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The Science Counselor

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Almost A Duty?

To the Catholic schools which have long been receiving this journal regularly although they may not have subscribed for it, or their subscriptions have expired, we submit the following facts for consideration, confident that prompt action will be taken.

THE SCIENCE COUNSELOR was founded and is maintained by Duquesne University as a "good work" in science and education. Its purpose, wholly altruistic, is to improve the teaching of science in Catholic schools, but it has won friends in other fields as well. Contributions from America's greatest scientists and educators have appeared in its columns. Humble teachers, too, have found a forum in its pages. In appearance, content, purpose and accomplishment it is a journal of which to be proud. It is important that the high standard that has been set for it shall be maintained.

THE SCIENCE COUNSELOR is not yet endowed. It has a long list of subscribers, it is true, and the patronage of advertisers has been generous and continuous. But the costs of publication have never yet been met, or even closely approached, by the receipts from all sources. For eight years the University has absorbed the annual deficit. In these days of mounting costs and dwindling receipts it is unfair to expect the University to continue to carry such a burden.

One thousand new subscriptions will ease the situation. Now is the time for non-paying schools to show their appreciation of what is being done for them, for science, and for education, by subscribing for one or more years. (One subscriber has paid for ten years, several for five years. One school sent in eleven separate subscriptions at one time.)

Will your school be numbered among the new subscribers? Send in one or more subscriptions today. **Under the circumstances do you not consider it almost a duty?**

The Editor.

Non-Science Courses for the Science Teacher

● By R. Ernest Dupuy, Colonel, G.S.C.
CHIEF, PLANNING AND LIAISON BRANCH, BUREAU OF PUBLIC RELATIONS, WAR DEPARTMENT, WASHINGTON, D. C.

Here a soldier, not an educator, points out in plain language the obligation of the science teacher to know more than science, to be interested in and concerned about world affairs, and at this critical time, to make his teaching contribute something of value to the country's wartime effort.

Colonel Dupuy's remarks on developing the ability to reason, on the "military mind," on quiz-program findings, on accelerated academic programs, and on geopolitics are especially pertinent.

This paper was presented before the April, 1942, meeting of the Pennsylvania Academy of Science.

●

My subject is the discussion of essential non-science courses for the preparation of qualified high school science teachers, from the national viewpoint, including national defense. I speak to you not as a teacher, but rather as a soldier who has made some study of the problem involved in the orientation of the American citizen, soldier and civilian, in world affairs.

A democracy can operate successfully only if its rulers, the people, comprehend the problems involved. These are primarily social, political and economic. The lives of our individuals of today are influenced, conditioned, and to a great degree determined by forces which can be termed scientific only in the broadest meaning of the word.

Therefore, it is essential that the schooling of the individual must include instruction in the type of reasoning and thought necessary to sound political, social and economic judgment. This focuses down to the basic fact that our schools owe it to their students to inform them concerning the realities of the world struggle now going on. Why? Because continuance of the American way of life which we so glibly prate upon, depends on the outcome of the struggle.

It is meet that Americans consider these things in a w rld today gone mad. A certain group of our citizens, enmeshed since November 11, 1918, in a fog of muddy reasoning entirely at variance with reality, have labored to discard old values, forgetting in the process that they had nothing worthwhile to substitute. Correlated has been the widespread veneer of jerry-built quasi-education produced by "snap" courses in an educational system based on quantity rather than quality. As a result the obligation of our citizens to work in continuity of interest and sacrifice to protect that citizenship was tossed out of the window. The cornerstone of the American foundation was removed. We are now coming slowly out of that fog, but something more than the present breast-beating attitude of many of the individuals responsible would appear to be necessary if the old values are to be restored.

Indicative of the loose reasoning of the last score of years is the fact that the expression "military mind" has become in certain circles a shibboleth of derogation—a libel rather than a label, as compared with kindred expressions denoting other professional minds. The explanation, of course, is that our average citizen, thank God, hates war. From hating war it is but one step—do we not analyze carefully—to projecting a royal wishful-thinking road to peace by despising those who wage wars. Hence this concept of the "military mind" as something sub-normal, a moronic intelligence whose sluggish reasoning and reactions have to do entirely with starting wars. As logically might we dub the fireman a menace to the community, the physician a moral leper. For, if war comes and we do not have in our midst the military mind, we are as helpless as the community without a physician, the settlement without fire-fighters.

The military mind is not in itself an exponent of brute force, but rather a specifically trained, educated intelligence, which by exercise of that training and education applies brute force in the national defense lest the homeland be engulfed. One willing party only is necessary to make a war. We know that today; the lesson has been expensive.

The nation's armed forces, it must be remembered, are but instruments of national will, carrying out that will and implementing its policy both internal and external. The nation's armed forces must consist of trained men who—of their own volition or despite it—will ignore the primal law of nature: self-preservation. Ignorance of this fact has always brought disaster.

Education must be designed primarily to give the individual the mental tools with which to work. That is, fundamental knowledge and mental discipline. Supplementing this, and of concurrent importance, is the inculcation of the broad general knowledge necessary to use the tools intelligently. This latter must include not only interest in matters outside the laboratory and away from the lathe, but a basic knowledge of these things which will give him a foundation in intelligent thought on it.

So much for generalities. Let's look at the basic problem posed in upbuilding a scientific education. Its purposes are three:—

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Origin of Coal, Oil and Natural Gas and Their Production From Plant Material

● By Ernst Berl
RESEARCH PROFESSOR, CARNEGIE INSTITUTE OF TECHNOLOGY, PITTSBURGH, PA.

Do not fail to read this important article.

It is a brief and characteristically modest report of the results of a series of studies of gaseous, liquid, and solid fuels, the publication of which startled the commercial as well as the scientific world. Gasoline can be made from farm products! No longer need we worry about dwindling natural reserves of petroleum.

Dr. Berl and his collaborators have proved that petroleums are formed in nature and can be prepared industrially from carbohydrate material, a discovery of limitless commercial possibilities and one that has upset completely certain long-held views concerning the formation of petroleums in nature.

●

The United States of America has more than 50 per cent of the world's reserves of solid fuels like bituminous and anthracite coal and lignites, and of liquid fuels like crude oil, and almost 90 per cent of the reserves in gaseous fuels like natural gas. The reserves of coals, with the present amount of extraction, will last several thousand years. This very favorable situation does not exist in the case of crude oil. At the present rate of use the proven reserves will be exhausted in about fifteen years. Naturally, there is much more oil under ground than the already proven reserves indicate. If unforeseen, great discoveries of it are not made, the oil which can be obtained at low cost will be exhausted in a much shorter time than the reserves of solid fuels,—perhaps within one or two generations.

Studies have been carried out by scientists for a long time in order to find out how nature produced in previous geological periods, and produces now, these very important fuels which are the basis of our civilization. Until recently it was believed that bituminous coals, as well as anthracites and lignites, were derived from the lignin content of plants. According to these wrong views, there is in nature a continuous transition of the plant material from peat to lignite over bituminous coal to anthracite. It was believed that the carbohydrate content of plants (cellulose, starch, sugars) would disappear completely through fermentation. It was thought, furthermore, that liquid fuels had been produced by heat decomposition of dead fish which had been killed in large quantities through geological catastrophes whereby sea water entered fresh water, or vice versa. It was also believed that asphalt was formed by a subsequent oxidation of crude oil hydrocarbons. According to these older viewpoints, practically all natural gas was produced by the methane fermentation of cellulose and other carbohydrates.

New studies carried out during the last seventeen years have shown that these older viewpoints cannot be brought into correlation with chemical, geochemical, paleobotanical and other facts and views. The fish theory has to be discarded for many reasons. In Texas and in Mexico there are 22 oil-bearing horizonts at the same place. There is no possibility that the same catastrophes may have been repeated 22 times in the same locality. The presence of enormous quantities of oil in certain oil fields also speaks against the fish theory. Paleobotanists have shown that those plants which are responsible for the formation of bituminous coals and anthracites, as well as of liquid crude oil and natural gas, many million years ago contained very little, if any, lignin. Only lignites and fusains (fiber coal) are derived from lignin material. The latter-mentioned fuels always show the so-called cell structure of lignin and the presence of methoxyl groups which are characteristic of lignin and its derivatives. In most cases upon incoalification in the absence of oxygen-contained gases, they give sandy coke.

It has been shown that carbohydrates when subjected to high temperatures in the presence of water give artificial carbohydrate coals which behave like certain natural bituminous coals. They have the same carbon content and upon mild oxidation they give the same aromatic oxidation products as natural coals. Like certain natural bituminous coals, they yield sandy coke. If this artificial incoalification is carried out in the presence of smaller amounts of alkaline-reacting rock material like limestone or dolomite, artificial bituminous coals are obtained which in every respect are identical with the natural coking bituminous coals. They give hard coke, show the same microscopic picture without vessel structure, and do not contain methoxyl groups, just like natural coal. Compared to natural bituminous coals, these carbohydrate coals show the same or a somewhat higher amount of bitumens. Bitumen is the part of artificial and natural bituminous coals which is soluble in certain organic solvents. The bitumen of artificial and natural coking coals decomposes below its boiling point. The resulting high-melting decomposition products cement the residual coal particles together to form hard or porous coke. If the main development of gas takes place during the plastic stage, porous coke is formed. If this development of cracking gases takes place before or after the

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Mr. Cadet Teacher:
Do You Know Your High School Science?

● By W. H. Neely
DEPARTMENT OF CHEMISTRY, FIFTH AVENUE HIGH SCHOOL, PITTSBURGH, PA.

Alert supervisors who train fledgling teachers in classroom and laboratory practices quickly discern defects or omissions in the science preparation of those who come under their direction. Surprisingly, the same deficiencies may be observed year after year. Shouldn't something be done about it?

In this paper Mr. Neely draws on his rich experience in teaching and teacher training to point out some of the more common stumbling blocks. They are simple things about which experienced teachers may have hazy ideas, too.

Read the concluding paragraphs of this article —more than once—with especial attention. Sounder advice cannot be given.

●

In a certain high school some years ago the principal was teaching a class in physics. As is sometimes the case with school administrators, this principal knew but little mathematics and not much science. In a particular formula in the physics text the expression *Sin A* was used. Having studied no trigonometry, this old-time professor called it the *sin of A*. At the time no one in the class detected his error in pronunciation. A year later I had as my roommate in college a member of this physics class. This young man enrolled in a trigonometry class, and when he learned that *Sin* A is read "sine of the angle A," his estimate of his former teacher dropped considerably. He carried the newly-found information back to his home town and during the rest of that principal's stay in that community the students and alumni called him "Old Sin of A".

In every class in physics or chemistry there are students who sooner or later will detect any lack of knowledge of the subject or any tendency on the part of the teacher to bluff. In teaching elementary chemistry it is well to call to the attention of the brighter students the possible exceptions to some law or principle. For example, in high school chemistry we assume that the valence of hydrogen is $+1$; but I tell the college prospects they will find in higher chemistry a few cases where it is -1.

During the past twelve years I have supervised some fifty cadet teachers doing practice teaching in high school chemistry. As a rule these student teachers know college chemistry from both the theoretical and practical viewpoints. Some of them are now holding teaching positions; others are doing excellent work in private enterprise. These young men, with few exceptions, demonstrate clearly that college chemistry has been thoroughly drilled into their minds. They are able to win and hold the respect of the high school students to a remarkable degree. But not infrequently, after I have explained some basically important principle in chemistry or in some related field, even the best of the cadets will approach me after class and tell me they have never heard of the item I had just explained; or if they have heard of it their understanding is hazy. I do not find fault with the college instructors for not correcting this weakness in their students. The college teachers assume that their students know high school chemistry and proceed to build upon what these students do, or do not, know. When I get new students in high school chemistry I assume they have the basic mathematics necessary for a successful course, but many of them do not.

I recall three cadets who were under my supervision a few years ago. These young men were really good chemistry students. They could balance the most difficult oxidation and reduction equations with ease. Building structural formulas to them seemed child's play. Their laboratory techniques were exceptionally good. After they had observed class instruction for six weeks and each had done a few turns at teaching, one of them, acting as spokesman during a conference said to me, "Before coming here we thought we knew some college chemistry. Now we are beginning to doubt if we even know our high school chemistry." I assured them they knew college chemistry well, but that they did need some polishing up in high school chemistry and physics. I then suggested that we have a class to review their weaknesses in elementary chemistry, this course to take the place of the usual formal and uninteresting conferences on pedagogical procedures to which students preparing to teach are subjected (there ought to be a law against such punishment!).

We held eight two-hour sessions which we all enjoyed very much. At the young men's suggestion they prepared for me a list of scientific facts and principles that had been cleared up or learned by them during their training period. I wrote to cadet teachers of former years, asking them to submit similar lists. I made the same request of student teachers that I had trained more recently. The composite list is too large for me to include in this paper all the material I collected. I shall discuss only the more important items that the greatest number of cadets had not understood.

The average college student becomes confused in the use of the terms *density* and *specific gravity*. Density is the weight of a certain volume of matter. The den-

sity of lead is 11.34 gm. per cubic centimeter; of water, one gram per cubic centimeter; of oxygen, 1.429 gm. per liter. In the English system density is usually expressed in pounds per cubic foot. Specific gravity, or relative density, tells how many times a given volume of matter is heavier than an equal volume of some substance taken as a standard. Lead is 11.34 times heavier than water, therefore its specific gravity is 11.34. If a liter of a certain gas weighs 2.858 gm., its specific gravity or relative density compared to oxygen is 2.858 divided by 1.429, or 2. In the metric system the density and the specific gravity of solids and of liquids are always numerically the same; in the English system they are never numerically equal. To illustrate: the specific gravity of water is one; its density is about 62.4 pounds per cubic foot.

Compare the lifting power of helium gas with the lifting power of hydrogen gas. Most students reason in this fashion: since helium is twice as heavy as hydrogen it will lift half as well. The correct solution of the problem is: 1.29 gm., the weight of a liter of air, minus 0.09 gm., the weight of a liter of hydrogen, equals 1.20 gm., the lifting power of a liter of hydrogen. Similarly 1.29 gm. minus 0.18 gm., the weight of a liter of helium, equals 1.11 gm., the lifting power of a liter of helium. Then, 1.11 divided by 1.20 equals 0.92 or 92 per cent. That is, helium lifts 92 per cent as well as hydrogen.

At most not more than half the college students I contact are able to give a satisfactory explanation of the valence of iron in the formula Fe_3O_4. This compound has a complex molecule made up of a molecule of FeO and a molecule of Fe_2O_3. The formula may be written $FeO.Fe_2O_3$. It should readily be seen that one atom of iron has a valence of 2, and two atoms a valence of 3 each. Similarly, Pb_3O_4 is considered to be $PbO_2.2PbO$. In this formula one atom of lead has a valence of 4, and two atoms have a valence of 2 each.

Practically all college students use the formula $\frac{V\ P}{T} = \frac{V_1\ P_1}{T_1}$, which represents a combination of Boyle's and Charles' Laws. In this formula V represents the volume of a gas under a pressure of P and at a temperature of T. V_1 represents the volume of the gas when the pressure and temperature are changed to P_1 and T_1 respectively. Let V_x represent the volume when the pressure is changed from P to P_1 with no change in the temperature. Then by applying Boyle's Law the proportion becomes $\frac{V}{V_x} = \frac{P_1}{P}$. Solving this equation, $V_x = \frac{V\ P}{P_1}$. Next, change the temperature from T to T_1, and apply Charles' Law. The equation becomes $\frac{V_x}{V_1} = \frac{T}{T_1}$. Substitute $\frac{V\ P}{P_1}$ for V_x and we arrive at the equation $\frac{\left(\frac{V\ P}{P_1}\right)}{V_1} = \frac{T}{T_1}$. This equation may now be written in the simplified form $\frac{V\ P}{T} = \frac{V_1\ P_1}{T_1}$.

Many college students are not able to apply Boyle's and Charles' Laws directly in combination to solve for change in volume. Suppose a gas has a volume of 100 cc. at 570 mm. pressure and a temperature of 364° Absolute. What will be the volume of the gas if the pressure is changed to 760 mm. and the temperature to 273° Absolute? X, the corrected volume, will equal 100 cc. multiplied by two fractions: the first to correct for change in pressure, the second to correct for change in temperature. Since the pressure increases, by applying Boyle's Law the volume should show a decrease. The fraction $\frac{570}{760}$ shows it decreases. Since the temperature decreases, by applying Charles' Law the volume will also decrease, and the fraction becomes $\frac{273}{364}$. The completed equation takes the form $x = 100 \times \frac{570}{760} \times \frac{273}{364} = 56.25$ cc.

In studying electrolysis I find cadet teachers uncertain as to the use of terms. Anode means the way up for positive electricity. It is the electrical terminal through which positive electricity is carried into a battery or electrolytic apparatus. Cathode means the way down. It is the terminal through which positive electricity passes from a battery or from electrolytic apparatus. During the charging of an automobile battery the positive terminal is the anode; in discharging, the positive terminal is the cathode. It is also correct to say that the anode is the terminal source of the electrons produced by an electrical generator. In electrolysis the anion is attracted to the positive terminal or anode and carries a negative charge; the cation seeks the negative cathode and is positive.

Although the change in volume of water with change in temperature has very important applications in our every day life, the average student knows little about the details of these changes. Starting with water at 100° C., and lowering the temperature, the volume decreases at a more or less uniform rate until the temperature becomes 4°C. At 4°C. water has its greatest density and least volume. Lowering the temperature from 4° to 0° causes a slight increase in volume. At 0° C., on further removal of heat, ice is formed with an approximate increase of one-eleventh in volume. When ice melts at 0° C., the decrease in volume is one-twelfth, not one-eleventh.

Even though we live in an age of electricity and invention, can the average college student preparing to teach science give to a wide-awake high school boy a satisfactory explanation of how a radio message is sent and received? Does he know and can he tell the use of the neon tube, and the photoelectric cell in

(Continued on Page Sixty-four)

Visual Education

• By Hubert N. Alyea, Ph.D.
DEPARTMENT OF CHEMISTRY, PRINCETON UNIVERSITY, PRINCETON, N. J.

This very practical article will be helpful to teachers who are interested in the techniques of visual education. And every teacher should be.

Note especially the opening and closing paragraphs of this paper. If you don't agree wholeheartedly with the statements contained in them there is something wrong with your thinking and your teaching. Perhaps you had better find out what it is before your Principal detects it.

●

"One picture is worth 10,000 words."

This Chinese saying of long ago ushered in visual education; and the teacher today has awakened to its potentialities. For visual education as a method of presentation is within the limited budget of any classroom. It is an art, not a collection of elaborate paraphernalia. The student should not be amused by the motion pictures, the slides, the charts and the demonstrations; he should be inspired to more serious work. The lecturer has succeded only if, by his one hour of lecturing, he has stimulated the student to three hours of hard labor.

Some of the techniques of visual education follow.

Slides

Standard 3½" x 4¼" lantern slides may be of several sorts.

(*a*) The usual glass slide may be prepared with or without the aid of a lantern by a number of devices.[1]

(*b*) Pencil drawings and data may be drawn on ground-glass slides, or on glass slides dipped into 10% gelatin solution and drained.

(*c*) Ink or carbon copy on cellophane sheets[2] gives good results. "Radio-mats"[3] consisting of thin cellophane sandwiched between red "carbon" paper give typing on both sides of the cellophane, and project a heavy black. The slide may be bound between glass plates in the usual manner, or protected by stapling between cellophane sheets.

2" x 2" Slides. The increasingly popular film-strip and 2" x 2" slides may eventually displace the large slide. The new S.V.E. slide binders[4] are convenient for rapid, inexpensive mounting. The film-strip, from which the frames may be cut, are available from many micro-film depots.[5] An apparatus costing about $50 for copying pictures, even in color, is described for the Leica and for the Argus cameras.[6] Details are also given for developing and printing 70 frames at a time on 35mm. film-strip. Recently reversal film kits[7] have appeared. They can be handled by a novice; the film taken from the camera is processed in half a dozen steps directly to the positive, without passing through the negative stage. Reversal film is preferable to ordinary positive film for this purpose, since a thicker emulsion is desirable. Details are also given for copying 3½" x 4¼" slides onto 35mm. film-strips.[6] The procedure is simple, and a thousand slides can be made in a few days at a fraction of the cost of large slides. Schools with large slides will find that a switch to the smaller size quickly pays for itself. Compare the cost of the standard slides with these prices for 2" x 2" slides: black and whites 6¢, bound; colored, 15¢, bound.

Projector: The writer prefers the 150-watt projectors without fan for dark room projection, and 750-watt projectors for daylight projection. In general the machines which are most satisfactory for both 2" x 2" and 3½" x 4¼" slides are the projectors with auxiliary sets of lenses. A buff wall is nearly as suitable as an alumi-

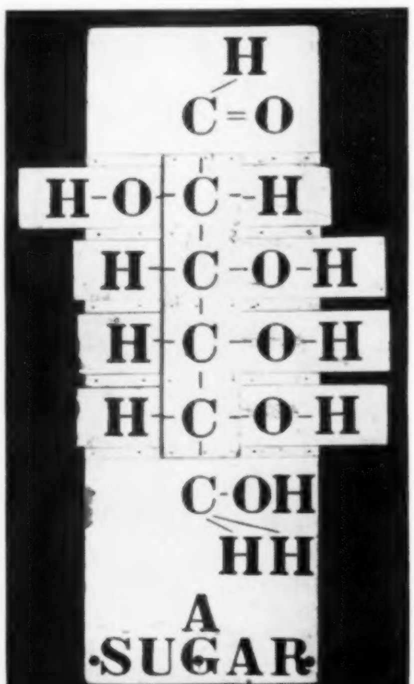

FIG. 1

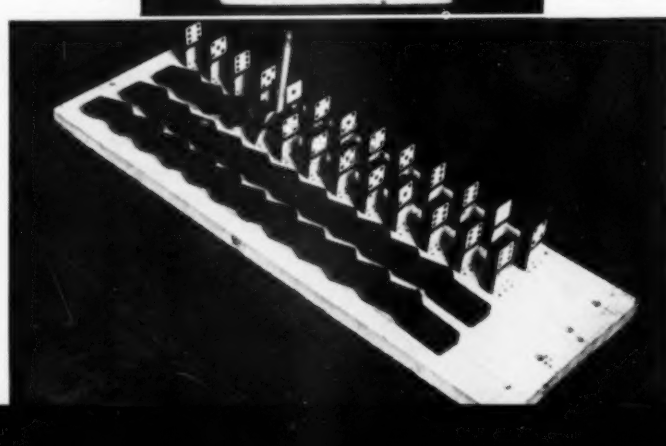

FIG. 2

num or beaded screen, and considerably more convenient. If the projector must be placed at the rear of the room, the lecturer may be at the mercy of his assistant, who usually is adept at pushing wrong switches, shuffling slides and projecting them upside down. Relief is in sight: automatic slide-changers to be controlled from the desk are now available.[8]

Blackboards

Light weight portable blackboards are very convenient for graphs and data which would cramp the regular blackboard space.[9]

Motion Pictures

Motion pictures, like slides, should be used intermittently throughout the lecture, but not as a means of relieving the teacher of some of his duties. When a teacher finds it easier to use a moving picture than to lecture, it means he is forfeiting precious time for personal contact with his class. That is, moving pictures should be *used* and discussed, not *shown*. For instance, a two-minute motion picture showing the "blow-off" of a Bessemer converter is unquestionably better than a slide or diagram of the same subject. The teacher should build a library of these "very short" film topics. For showing intermittently throughout the lecture, the projector should be controlled by relay or direct line to the lecture desk.[10] The moving picture shorts may be temporarily joined, not by cutting and cementing but merely by overlapping the strips and fastening with 2" lengths of ¼" cellophane on each side of the film. Afterwards the strips may be quickly separated and filed away.

Of the many films[11] available few are suitable to show in their entirety. This latter category includes:

1. Aluminum: Mine to Metal. Fabricating Processes. Aluminum Company of America. 2 reels, 16 mm., sound and silent.
2. The Magic Key of Chemistry (Bromine from Seawater). The Dow Chemical Co., Midland, Michigan. 2 reels, 16 mm., silent.
3. The Random Interchange of Organic Radicals. Dr. George Calingaert, Ethyl Gas Corp., 723 East Milwaukee Ave., Detroit, Michigan. 1 reel, 16 mm., sound.
4. Steel: Man's Servant. Mr. Robert Dalton, U. S. Steel Corp., 71 Broadway, New York City. 16 mm., sound, technicolor.
5. Story of Sulfur. U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa. 2 reels, silent.
6. The Story of Alloys in Steel. General Publicity Department, Union Carbide and Carbon Co., 30 E. 42nd St., New York City. 16 mm., sound.
7. Molecular Models of Butyl Rubber. Kodachrome. Presented by Dr. Per Frohlich at the Detroit A. C. S. meeting, September, 1940. Write J. R. Brown, Jr., Esso Laboratories, P. O. Box 243, Elizabeth, New Jersey.

Also there are commercial education films[12] of varying degrees of usefulness; and Hollywood films[13] of which there are few subjects in chemistry, but numerous other scientific shorts selected from 15,000 commercial shorts by a panel of educators, and copied on 16mm. sound.

Exhibits

In general exhibits are useful only to the student preparing them. Exhibits may be conveniently mounted on 20" x 20" five-ply boards coated with aluminum paint. Biological specimens are strikingly displayed in methacrylate plastics.[14]

Demonstrations

Experiments and lecture table exhibits should be carefully staged, so as to dramatize the event. The students will learn nothing from a lecturer who waves at them bottles of copper pellets or of potassium. Action is desirable. Not far from the ever-popular Futurama at the New York World's Fair, which was visual education at its best, a million dollars was spent on an exhibit which did not attract crowds simply because it lacked the vitality and dramatic motion of the Futurama. Two action demonstrations are shown in Figures 1 and 2.

Figure 1 illustrates a monosaccharide, although the lecturer should explain that the lactone ring is missing. The four movable boards in the center contain the letters H-O-O-H, one O being hidden by the row of carbons in the center. A board which appears as H-O-C-H may be slid to the right, and then reads H-C-O-H. By this device, a number of pairs of isomers may be illustrated.

Figure 2 illustrates a "chain reaction," such as in the combination of hydrogen and chlorine:

$$Cl_2 + \text{light} \longrightarrow Cl + Cl \qquad \text{chain initiation}$$

$$\left.\begin{array}{l} Cl + H_2 \longrightarrow HCl + H \\ H + Cl_2 \longrightarrow HCl + Cl \end{array}\right\} \text{chain repeats itself}$$

$$Cl + X \longrightarrow XCl \qquad \text{chain breaking}$$

The model may be used to illustrate a number of points. (a) The reaction is initiated by light, heat, catalyst, *etc.*, illustrated by pushing over the domino at the head of the row. (b) Many molecules react per initial light quantum absorbed, in contrast with the Einstein photochemical equivalence law. (c) Inhibitors (pencils) break chains. (d) Increasing the inhibitor concentration increases the number of chains broken. (e) An inhibitor molecule is oxidized in breaking a chain. For this reason the substance is called an "inhibitor," not a "negative catalyst." If four chains, in Figure 2, are started in unit time, only four chains can be broken; and therefore only four inhibitor molecules can be oxidized. Increasing the inhibitor concentration may break the chains sooner, but still there are only four chains to break; *i.e.*, only four inhibitor molecules are oxidized. In other words, the rate of oxidation of the inhibitor is independent of the inhibitor concentration, above that concentration of inhibitor where all four chains are broken by the inhibitor.

(Continued on Page Sixty-one)

Sugar in the Diet of Man

• By C. Jelleff Carr, Ph.D., *(University of Maryland)*
ASSOCIATE PROFESSOR OF PHARMACOLOGY, SCHOOL OF MEDICINE, UNIVERSITY OF MARYLAND, BALTIMORE, MD.

We have always taken sugar for granted, but now that our supply is so strictly rationed, everyone is thinking about this "necessity."

Why is it so scarce? Is it essential in the diet? Is it good for us? Is cane sugar a better food than beet sugar? What is the fate of sugar in the body?

What about sugar substitutes?

All these questions and many more are discussed in this timely article. It contains information you will be glad to have.

•

As millions of American housewives march into the schools of the nation to apply for the family share of sugar, we ask the question, Why do we eat sugar?

Many items of our diet contain sucrose in the natural state. Do we *need* this disaccharide as a chemically pure substance in our food? When did man first learn to use sucrose as a foodstuff, and thus establish a new basic industry? In 1941 it supplied the enormous total of nearly 8,000,000 tons of a pure crystalline compound to the American consumer at a few cents a pound. What is the story of this industry? A nation at war is almost certain to lack sugar. Even more than man, aerial bombs, submarine torpedoes and artillery shells are ravenous consumers of sugar.

The Development of Sugar as a Foodstuff

The discovery of cane sugar is credited to the Arabs, who in medieval days brought sugar from the Orient and created for it such a demand that fruits and honey were displaced as sweetening agents in man's diet. The sugar beet is said to be indigenous to Europe, but it was not until 1799 that sucrose was isolated from them. With the new beet sugar the temperate zone began a competition with the Orient for supremacy in world sugar production. The sugar cane and the sugar beet became rivals. The sugar produced from each is identical, contrary to general opinion. Napoleon subsidized the beet sugar industry and with the sugar thus produced helped finance his wars. Germany developed sugar extracting machinery and improved the yields of sugar from 5 to 17 per cent of the weight of beet. Beet sugar forged ahead rapidly in the race against cane sugar. By 1900 it dominated the markets of the world. In 1903 the world produced 6,000,000 tons of beet sugar and 4,000,000 tons of cane sugar.

Economically there are many problems in the sugar industry. For example, the sugar beet at best can produce but two tons of sugar per acre with highly paid American labor. Beet sugar production in our plains area is a great agricultural development. Sugar cane yields as much as seven tons of sugar per acre with cheap labor. These facts have caused many bitter controversies in the industry, in Congress, and in the farming districts involved. Tariff quotas have been established to restrict importation of cane sugar, only to be changed under pressure for economic reasons. Today, cane sugar holds supremacy. In 1940, the world production was 22 million tons of sugar. Of this amount only 12 million tons were beet sugar.

The United States, after a few early failures at sugar beet farming, established the industry successfully about 1890. In 1940, our production was third among all nations. Expansion of the beet sugar industry has been stimulated by tariffs on the cane sugar imported from foreign countries. Now we are at war, and once again we require sugar in large quantities. We need much sugar from the Latin American countries as well as all that we can produce ourselves. One wonders how friendly these countries will be to us now that we need their sugar, after we have maintained for many years a trade policy detrimental to the development of their industry.

Why Do We Eat Sugar?

Although it has been known to man for 2000 years, sugar was still a table luxury 200 years ago. To the general population then it was familiar mainly as a medicine. Today, the average American consumes over a hundred pounds of sugar every twelve months. Why do we eat it? Is it a body necessity like salt? The answer is that there is no bodily requirement for sucrose other than that it is a good source of energy and it tastes sweet. An educated palate, trained from childhood to accept sweet tasting food, accepts readily a diet rich in sugar. Whether sucrose is the best form of sugar for human consumption is open to question. That it is a good source of energy and capable of giving rich stores of glycogen in the liver is well understood. But while polysaccharides and disaccharides constitute a large proportion of the carbohydrate food of man, their use in the body depends upon their conversion to simpler types and their final metabolism as glucose. Medical science cannot now answer the question whether sucrose is the best source of carbohydrate for body energy. Would pure glucose be better? Would some other sugar or sugar fragments be better still? Would levulose be a better sugar for human consumption. For an answer to these questions let us turn to the scientific literature.

The Fate of Glucose in the Body

First of all, there are one and one-half million diabetics in the United States. Forty per cent of them take insulin injections. In these individuals the utilization of sugar is most carefully watched. From a study of their condition we have learned a great deal about carbohydrate metabolism. The oxidation of glucose in the body has been compared to alcoholic fermentation by yeast, and for years the comparison has been alternately challenged and supported by various workers. The question is still unsettled. It is not known exactly how the body burns glucose. True, a great mass of information is available. But the subtle manner in which the muscle cells utilize the sugar of the blood stream to do work is still a mystery. Admittedly the question is of fundamental importance and should be answered before any attempt should be made to study the sugars related to glucose. Perhaps the answer may come in a round about way from the study of chemical constitution and metabolism.

Chemical Configuration and Metabolism

Theoretically there are sixteen possible organic compounds having the general formula $C_6H_{12}O_6$, if one accepts the customary aliphatic carbon to carbon linkage. All sixteen isomers are known. Eight are mirror images of the other eight. These are glucose, mannose, gluose, idose, galactose, allose, altrose and talose. Unfortunately, because most of the isomers are museum curiosities, they have been studied very little from the standpoint of metabolism in the animal organism. At first glance, one would suspect that there would be no difference in the manner in which these isomers would burn. Experiments have shown that this is not the case. With the isomer galactose, after administration by mouth, the concentration in the blood increases and the blood glucose rises, but the sugar is metabolized more slowly than glucose. Insulin is necessary for its combustion, for in diabetics it is valueless as a source of carbohydrate. On the other hand, galactose is absorbed more quickly than glucose from the intestinal tract. Mannose, the only other isomer that has been studied, is still less active than glucose.

The sugar alcohols and their anhydrides corresponding to these isomeric sugars have been studied in recent years. They have been shown to behave in an irregular manner, similar to the aldehydes. To give a word picture of the tremendous task involved in such studies, it is estimated that it would require at least two hundred years to study but a few of the isomers of glucose, their alcohols, ketones, acids and anhydrides, assuming that they are available for study as chemically pure substances. Unfortunately, the nature of the problem is such that by simply doubling the number of investigators the problem cannot be solved in half the time.

To return to the original questions, obviously the consumption of large quantities of sucrose does not produce acute poisoning. Neither are investigators led to believe that massive consumption of a rich carbohydrate diet over long periods produces any inclination to diabetes. The human body is capable of developing a tolerance for high carbohydrate diets, witness the rice diet of the Oriental races and the well known fact that diabetes is practically unknown in their countries. On the other hand, the disease is more common in our modern cities than in primitive rustic communities. It is interesting to note that the Eskimo, who lives on a high fat diet, is incapable of tolerating large amounts of carbohydrate although he may develop a tolerance.

Wartime Demands for Sugar

It has been estimated that the powder required to fill five 16" shells requires alcohol from as much sugar as an acre of the finest Cuban land can produce. Alcohol produced from sugar sources is required in tremendous amounts in our war industry. To meet this demand domestic sugar producers are now attempting to increase yields, and foreign production is soaring under the stimulus of abolished trade limitations. The national situation so far as sugar consumption in the United States is concerned is far from cheerful, and limitation of the individual consumer is necessary. It is, therefore, interesting to speculate about other sugars or sweetening agents that might possibly be utilized by the housewife.

Substitutes for Sugar

Chemically unrelated sweetening agents, such as saccharin, are not acceptable in the diet. They have no dietary value as foods and they are objectionable to many individuals. The chemically related sugars or sugar alcohols, however, might serve as substitute sweetening agents. In fact, many of these compounds possess a sweet taste that is pleasant, although quite unlike sucrose. Mannose is an exception. It is a bitter sugar. Any sugar that is to be used in the diet as a sweetening agent must be reasonably cheap, and available in large amounts. Few compounds satisfy these two demands. Considerable attention has recently been attracted to the production in large quantities of the rare sugar alcohols from cheap corn syrup. These inexpensive sweet-tasting substances, heretofore costly laboratory curiosities, have become available for study in the laboratory and from them have been developed many novel products.

Mannitol, one of the sugar alcohols so prepared, possesses a delightful, sweet taste. It serves as a foodstuff in small amounts, in larger quantities as a laxative. It is a non-irritating white crystalline powder. Sorbitol, a related sugar alcohol, also produced from corn syrup, has found a place as a sweetener in the diabetic diet. Mannitol is not likely to be used as a foodstuff since after nitration it has been found to be an excellent explosive. Levulose, produced cheaply from artichoke tubers, possesses many advantages. Its taste is sweet and this sugar is well tolerated by the body.

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Borodin

Symphonies and Syntheses

• By Edmund Yochum, B.S., *(Duquesne University)*
GRADUATE STUDENT, DUQUESNE UNIVERSITY, PITTSBURGH, PA.

It is seldom that a great scientist is also a great musician. Borodin combined both talents.

It is seldom, too, that one finds a student of chemistry who is also keenly interested in music. Mr. Yochum happens to be such a rarity. He tells well the story of a man some call an artistic chemist and others a scientific musician.

This paper was submitted as one of a series of papers in a course in the history of chemistry at Duquesne University.

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"Scientific men—the eminent Einstein an exception—are notoriously unsympathetic to music, and consequently it is surprising to find, as the product of the same closely logical mind that produced the standard work on *The Solidification of Aldehydes*, these mad and intoxicating audible rhythms which we call the *Polovetsian Dances*."

Whether this gem (found among the *Victor Program Notes*), and the generalization which it contains, is true or not, and it probably is not, will not be discussed here, but Borodin was *the* living example of what the above statement calls surprising. Here was a man, equally eminent as composer and as scientist, interpolating musical compositions, creations of simple fancy, with chemical contributions requiring some of the purest logic of which the mind is capable.

Alexander Porphrievich Borodin was born in that much-named city which was then St. Petersburg, on November 12, 1834, the illegitimate son of Prince Guedeanoff, heir to the throne of Imeritia. This was a small kingdom in Transcaucasia along the Black Sea. During some trouble with the Turks, Imeritia was befriended by Russia and as a result became part of the Czar's country, thus leaving Borodin's father an "unemployed king." However, in compensation the Prince was given a substantial pension which enabled him to live in comfort if not in affluence, and to provide for his son every educational advantage in the two fields in which he showed ability even at an early age.

In these congenial circumstances Borodin began to compose at the age of nine. At thirteen he had written a concerto for flute and piano, which likely was not very good as it has not survived. He quickly learned to perform on the flute and piano with fair skill, and he attempted with tolerable success the clarinet, 'cello, oboe, and some of the brasses.

It is interesting to contrast his early life with that of the greatest of all Russian chemists, Mendeleeff, later to become his lifelong friend. Mendeleeff was nine months his senior, in painfully meager circumstances, not very studious, and having little love for the classics, especially literature, but probably music as well.

Borodin's father, of somewhat more practical bent, felt that it would not become a member of Royalty to be a professional musician, a career not thoroughly reliable even at that time, and accordingly a future in medicine was outlined for the boy. In due time he entered a preparatory school, but as chance would have it a fellow student was Schthgleff, later to be known as a teacher of music. The chemistry lectures had Borodin's undivided attention, but after class it was his custom to play piano duets with his friend for hours. At sixteen he was matriculated in the St. Petersburg Academy of Surgery and Medicine, where he applied himself to good advantage except for occasional musical "relapses." Once he cut classes for a whole day to hear the performance of some chamber music, to the great annoyance of his instructor in chemistry, the illustrious Zinn, who remarked as to the futility of "trying to hunt two hares at one time". Alexander Porphyrievich must have felt the rebuff, for he redoubled his efforts so that in 1856 he was given a position in a Military Hospital until his graduation as a Medical Doctor in 1858. It appears that his stay at the hospital was not too agreeable; the work was distasteful to his keen sensibilities and he determined then never to follow the profession with any intensity. It was at the hospital that he met Moussorgsky, who aired his ideas on the establishment of a Russian National School of Music and thus greatly influenced the future artistic career of this chemist who wrote music.

The brief period of practice that followed graduation was interrupted by an appointment to the chair of chemistry at the Academy. This, too, was of short duration for he and some others—among them Mendeleeff—were sent to other countries to continue their studies under the already famous western masters. The time was surely opportune for such study. This was the period boasting of men such as Kékule, Bunsen, Kirchkoff, Rosere, Wurtz, and Erlenmeyer, who already had among their assistants such men as Bayer, Volhard, L. Meyer, Beilstein and Quincke.

At Heidelberg Borodin found conditions unusually agreeable. Under Kékule and Erlenmeyer he studied organic chemistry for the next three years. He and Mendeleeff had, besides chemistry, one other taste in common: the desire to see the country. Together they

undertook hiking excursions, often of many days' duration. In these surroundings he temporarily forgot the ambition Moussorgsky had fired in him. He attended numerous concerts and recitals, one of the results being that he met Catherine Protopova, a talented concert pianist. This was a most happy occurrence, for she later became his wife.

Before returning to Russia, he journeyed to Paris where he met the great Wurtz and became interested in the aldehyde condensation reactions which later he spent years in investigating.

The year 1862 saw him back in St. Petersburg. He married, and after receiving a permanent appointment at the Academy as assistant lecturer in chemistry, he and Catherine took up residence in a part of the laboratory building. The daily routine allowed some spare time which was devoted to the arts, with especial emphasis on music. The Borodin apartment became the gathering place for Moussorgsky, Rimsky-Korsakoff, Balikirev, and Cui, who, with himself made up the group later known as the "Circle of Five". Moussorgsky had again converted him to musical nationalism. He studied composition under Balikirev and began his First Symphony.

This work was not to be finished for five years, as here also began his chemical researches which continued till his death. His first published paper was on the tendency of hydrofluoric acid to form double salts, and more especially "acid" salts. At this time Avogadro's Hypothesis had not been vindicated. The molecular weight of hydrofluoric acid was as unknown as fluorine itself. HF was classified with the other hydrogen halides which it resembled somewhat, and by analogy was supposed to be monobasic. Borodin found that equivalent quantities of a normal fluoride and an acid (even one as weak as acetic would do) yielded an acid salt:

$$CH_3COOH + 2KF \longrightarrow CH_3COOK + KHF_2$$

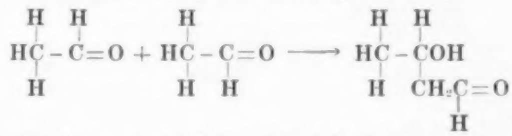
The conclusion was that the HF molecule is at least dibasic, a conclusion which was confirmed when Mallet measured the molecular weight of HF in 1881. Borodin also found that HF formed molecular compounds, similar to water hydrates, with a great many substances. Moreover, he drew the proper conclusion that these two phenomena are related, although he made no attempt to explain the mechanism, which, indeed, has been clarified only recently.

A simple way to make metal alkyls had at that time been shown by Beilstein, and Borodin tried the effect of an alkyl-zinc on dichloro-iodomethane, giving zinc chloride, zinc iodide and the free alkene.

Almost all his later researches were on aldehydes and their remarkable tendency to form polymers. He discovered the interesting reaction of sodium on valeraldehyde. Instead of getting a simple substitution product as he expected, a mixture resulted. On analysis, the mixture gave substances which were not the looked-for residues from the decomposition of the aldehyde, but actually compounds of apparently ***higher*** molecular weight than the decomposed valeraldehyde. He suggested that the principal action of sodium on aldehydes is to remove water, secondary reactions resulting from the hydrogen and free base formed. To explain the presence of the "decomposition" products he offered these reactions:

$$2CH_3CH_2CH_2CH_2CHO \longrightarrow C_{10}H_{18}O + H_2O$$
$$C_{10}H_{18}O + 4H\text{(nascent)} \longrightarrow C_{10}H_{21}OH$$
$$nC_{10}H_{18}O \longrightarrow (C_{10}H_{18}O)_n$$
$$4CH_3CH_2CH_2CH_2CHO \longrightarrow C_{20}H_{38}O_3 + H_2O$$

The base was presumably responsible in some way for the polymerization which had taken place, and the action of both acids and bases on ordinary aldehyde was next tried, with the result that, in 1872, he obtained a reaction which he correctly outlined:



The liquid condensation product is, in fact, identical with Wurtz's "aldol", prepared almost simultaneously with Borodin's discovery. Borodin found that the aldol could be oxidized to beta oxy-butyric acid, a reaction which has helped to clarify the formation of butyric acid from fermenting carbohydrates, and he was possibly one of the first to describe "beta oxidation" whereby butyric acid becomes oxy-butyric:

$$CH_3CH_2CH_2COOH \longrightarrow CH_3CHOHCH_2COOH$$

When aldol was heated with sodium acetate solution, water was removed and crotonic aldehyde formed;

$$CH_3CHOHCH_2CHO \longrightarrow CH_3CH{:}CHCHO + H_2O$$

This is an important tool in syntheses as it affords another way to form a double bond. Aldol is of added interest today as a possible way to make synthetic rubber—butadiene can be synthesized from aldol—and thus rubber can be made from coal through the steps: coal, calcium carbide, acetylene, acetaldehyde, aldol, butadiene, "rubber".

Borodin published a short article noting that diphenylglycollic acid is formed when benzene is heated with sodium ethylate, but the mechanism was not determined. Another article reported the results of decomposing castor oil by heating at atmospheric pressure, giving a considerable yield of his old favorite—valeraldehyde.

Laurent, in 1844, had reacted ammonia with benzaldehyde and obtained hydrobenzamide, or lopin, which, when heated, was transformed into an isomer, amarin—the exact structural difference between the two remaining unanswered, a challenge to any keen experimenter. Borodin undertook the study and found that in hydrobenzamide, all the H's are bound to carbons, while in amarin, one or more is attached to the ammonia residue. Hoffmann and Martius had established that a hydrogen from one of the attached groups of a secondary amine was transferred to the nitrogen when a primary amine is formed by heating a secondary type,

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Teacher or Subject?

• By Robert T. Hance, Ph.D., *(University of Pennsylvania)*
DEPARTMENT OF BIOLOGY, DUQUESNE UNIVERSITY, PITTSBURGH, PA.

Do you sometimes recall with pleasure and appreciation some teacher who deeply influenced your life? Was it the teacher, what he taught, or how he taught that impressed you?

Your considered answer to that question should influence your own teaching today.

Dr. Hance presented this paper at the recent Edinboro meeting of the Pennsylvania Academy of Science.

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We are living in an educational day when administrative organization is sometimes glorified beyond the spirit of the work being administered. Naturally, records must be kept, reasonable routines established, and some semblance of unity striven for. But card catalogues, prerequisites, mail order lists of courses described as fitting furniture for the mind, make a fearfully drab background for all too frequently drab instruction that merely mouths the sayings some one else has set down in the text. Such an instructor may perhaps have been taught the methods of teaching but he could never be taught to teach.

Students come to school to learn facts—the facts of life—but these remain of encyclopedic interest and quality if not integrated by the instructor's personal common sense and understanding of the world of human nature. So-called modern education, at all levels, has come to be a production-line performance with theoretically desirable informational facts being applied at specified places along the line. To accomplish this calls for great administrative energy and ingenuity to see that a proper supply of acceptable facts reach the educational production line at the proper intervals.

And we have a notion that education leads to reasoned thought!

Educational administration is worthy of its hire and importance only when directed by human beings who themselves are exceptional teachers and who can stimulate and lead those under them in the right direction. There can be no formula set down for such direction; their success cannot be blueprinted in a methods course; they can merely be pointed to.

I have had some occasion recently to think back over some of those teachers under whom it has been my good fortune to sit, to work and to play. It did not take long to decide that what they taught was of considerably less importance than was their use of the materials they laid before me.

One of these teachers taught the facts of zoology as the basis of a profession. But he taught me vastly more, and quite incidentally, of the kindly human implications of such knowledge.

Another led me into the intricacies of a sport that called for skill and resulted in pleasure and a realization of how some things are properly done. The point of his sword, however, taught no mere technique but again a way of living.

Obviously the materials with which teachers deal must vary. But these only justify exposure for the training of others when they serve as a medium of expression of the teacher's own interpretation of the world of living activities. From this point of view it makes no difference at all whether the instructor is best versed in history, in mathematics, in biology, or in fencing providing he knows more than the mere facts and skills of these fields of learning. If he is a good teacher his expert knowledge of even a limited range of human activities has enabled him to see life as a sensible whole and such understanding passes over to students usually without the realization of the instructor.

Much nonsense is perpetrated in the name of education which in the end can only be the skilled and personal encouragement by sympathetic people of those qualities in others best worth amplifying. The ideal of Mark Hopkins at one end of a log with his student at the other is, for many, a satisfying picture of all that is good in instruction. However, I am deeply sensible of the fact that in much of my own training I was never conscious of the log. My best hope for the students of the future is that they will have the opportunity to work with teachers who live their subjects—but do not preach them. ●

Free Teaching Aids

Do you know of the instructional material offered free to teachers by the National Association of Manufacturers, 14 West 49th Street, New York City?

If you do not, you should write for their newly published *Bibliography of Economic and Social Study Material*, which will be sent gratis. It lists booklets, motion pictures, slide films, lantern slides, transcriptions of radio addresses, and posters that are supplied by the Association upon request. As the title indicates the service is not designed primarily for science teachers but material that will be helpful to them is included.

You might care to make use of the service in connection with your department of social studies. ●

Science Controls Household Pests

● By Marita Bos
MARYCLIFF HIGH SCHOOL, SPOKANE, WASHINGTON

This essay was selected by the board of judges as the most meritorious submitted in the 1942 Duquesne University National Science Essay Contest. The several honorable mentions won in the contest were announced in our March issue.

Miss Bos is fifteen years old. Her essay was supervised by her chemistry teacher, Sister M. Celine, F.S.P.A.

A gold medal was awarded Miss Bos. A silver trophy has been presented to her school for one year's possession.

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America is faced by the dangerous Axis powers on the one hand, and an equally aggressive force of household pests on the other.

Thus far we have been waging a completely mechanized, defensive war against the first of these enemies,—a war of tanks, planes, and guns. But how are we combating the second offensive, which has been active since the dawn of civilization,—a well-equipped, huge, mobile army composed of rats, mice, mosquitoes, flies, cockroaches and bed-bugs—a super - blitzkrieg force?

Why term it a blitzkrieg force? For obvious reasons, since this army causes more sudden and unexpected deaths than those of all the wars of history. The army is a fast moving, hard hitting, cooperative force, backed by the strongest air craft in the world.

Where is the enemy lurking? Is the danger imminent? What is science doing to combat this army? The answers to these questions are of vital importance in undertaking the defensive.

The first objective of this blitzkrieg offense is the rat. Considered as one of the lowliest of animals, this rodent presents a battle front to the cleverest strategists. In three years a pair of rats, if unmolested, can produce 350,000,000 offspring. Certainly, if preventive measures are not taken America will need another Pied Piper of Hamelin. Rats alone, by carrying bubonic plague, paratyphoid, and hydrophobia, have killed more people than those killed in all the wars since the time of Christ. It will be no easy task to rid the world of these rodents, for they are alert to those poisons which have characteristic odors. They also become adept at springing traps so that they can eat the bait. Happily, science comes to the rescue. Modern exterminators profit from the results of scientific investigations, and use one of the several effective poisons, such as arsenic, thallium, sulfur fumigation, strychnine, or red squill. Of these, the most effective is red squill, a Mediterranean plant for which rats show a fondness. Another substance, the Danysz bacillus, could wipe out the entire rat race in one epidemic, but it is not used extensively because of the danger of contaminating human food.

We leave the Gargantuan members of the army and inspect the rear guard, the mosquito, a small winged

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MARITA BOS

The Catholic View of Evolution

● **By Barbara Raupp**
SENIOR STUDENT, FONTBONNE COLLEGE, ST. LOUIS, MISSOURI.

By chance, just after the Editor finished a first reading of this paper he happened to meet on the Campus Msgr. George Barry O'Toole. This famous authority kindly consented to read Miss Raupp's paper. When he had done so, he approved it almost without change, a high compliment indeed to the young writer who is an undergraduate major in philosophy.

This paper states clearly and succinctly the sometimes misunderstood Catholic stand on a question that is taboo in most public schools, although it is freely discussed in schools conducted under Catholic direction.

●

The imaginative writer might say that evolution is in itself a thrilling word. His uncontrolled mind might race into realms of the imagination to discover that man evolved from an amoeba or perhaps, from a butterfly or an ape. At the other extreme is the writer who refuses to investigate the question of evolution because it is disgusting to him to know that man might have such lowly ancestors as the fish or the ape.

The Catholic is neither of these two extremes. First of all he believes in God—a God Who is Truth. Therefore, whatsoever he professes to believe must be the truth—the unbiased, unprejudiced truth. Accordingly, the Catholic approaches the topic of evolution not with an imaginative mind prepared to accept any likely theory, nor as an agnostic refusing to admit proof when it is presented. If evolution is a scientific fact, it is a truth. Hence it is compatible in every way with the Faith, because Faith is truth and truth is one.

But what is this word evolution which is at least vaguely familiar to all of us because pseudo-scientists write alarming articles for newspapers and magazines? Etymologically the word means an unrolling. Morrison and Rueve tell us simply that "The theory of evolution is one that professes to explain *how* present organisms came into being, not why they did".[1] Evolution, then, must be investigated as a process. One of the several possibilities which follow from a study of the process of evolution is phylogenetic evolution, which is the genesis of groups of organisms from groups of simpler organisms. This term is divided into polyphyletic and monophyletic. The former theory holds that there are several original forms, the latter, that there is but one original form. These forms of phylogenetic evolution are in opposition to the ontogenetic theory of a true organic evolution which is the development from simpler to more complex structure.

In discussing evolution, immediately the question arises: "What about man?" More specifically, many of us ask, "What about me? Does my family tree have branches from the ape family?" These are the questions that the Church seeks to answer, for the origin of God's highest creature—man—is much more the concern of the Church than is the question of the evolution of the lower organisms.

Briefly, these questions are answered after the facts have been pondered. The animal, the ape, the fish, or the butterfly has a body and a brute soul; man has not simply a body but he has a vital principle—an immortal soul. Man cannot have evolved in entirety from the animals. Perhaps his body did. But science has not proved positively that it did, though if such a theory should become an established fact the Church would and could recognize it is a truth, for it is antagonistic to no dogma of Faith. But the one definite teaching of the Church in regard to the problem is that the rational soul of man was directly created by God and placed in the body of man, (which may or may not have evolved from some inferior animal). The soul is a spiritual substance; the body, material.

That the material may have evolved is discussed at length in various theories advanced from time to time by scientists down through the ages from the early Greek thinkers to the present day scholars. Thales declared that all things arose from the water.[2] Anaximenes postulated both earth and water as the substance from which creatures arose. Aristotle is held to be one of the founders of evolution. He taught the gradual change from the simple or imperfect to the complex or perfect.[3] Epicurus believed in natural rather than supernatural causes for evolution. St. Augustine, the Father of Theistic Evolution, rejected the theory of special Creation as a reflection on the omnipotence of Almighty God. Augustine preferred to believe that God first created matter and that this matter was acted upon by the natural forces God created.

In the seventeenth century through the work of Harvey, Bacon, Malpighi, and Swammerdam, interest in the evolutionary theory was revived. In the eighteenth century the theory was the subject of further study under Buffon and Linnaeus. But it remained for the scientists of the nineteenth century to popularize evolution, Lamarck, Cuvier, Lyell, Darwin, and Wallace. Instantly recognized for their theories are Lamarck and Darwin. The former's noted phrase is the "transmission of acquired characteristics." The latter's, Darwin's, is that "slight variations just happened."

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[1] *Think and Live*, p. 102.
[2] Henry Fairfield Osborn, *From the Greeks to Darwin*, p. 34.
[3] James Watt Mavor, *General Biology*, p. 764.

In this brief glance over the history of the theory of evolution, the Catholic viewpoint is challenged again and again and difficulties arise in the defense of the theory as pseudo-scientists attempt to prove the evolution of the body, then the brain, then the mind, then the soul. Against this last form Catholics must be continually on guard. It is a theory heretical to their faith in God, in Truth. Realizing the standpoint of men through the ages on this puzzling question, one naturally becomes concerned with what contemporary scientists believe in regard to evolution. The Catholic viewpoint can then be proved in detail according to the errors prevalent in the world today and yesterday.

A public library shelf is a likely place to find the trend of twentieth century thought. It is a place where the pulse-beat of the time may be measured by the knowledge the people are assimilating from that source. In most libraries the books on this subject fill several shelves. Their number proves the popularity of the topic. A few books selected at random are evidence of the "modernist" stand. Some are alarming. Some are scientifically sound. Some very few are Catholic, and correct.

Vernon Kellogg, an obvious evolution enthusiast, commences his work by exclaiming, "Evolution is an exciting word!"[4] The tone shown in this statement is characteristic of the whole work. Departing from the scientific, he makes his work imaginative. Chapter XIII, "Evolution of the Mind", proves his bewilderment as he refuses to admit the difference between brute and human souls.

In 1923 William W. Keen wrote a book with a promising title, *I Believe in God and in Evolution.* It contains a Christian doctor's reasons for believing in evolution as founded on the Bible and his personal professional experiences, but it offers no proof or statement of fact acceptable by the scientist.[5]

A Primer of Darwinism by Joseph and Fanny Bergen is but a blind simplification of Darwin by two of his very devoted disciples. Attacking the special creation theory postulated by many, they state: "It is not really even an attempt at a scientific explanation of the facts of animal and vegetable existence, but is as evidently a mode of avoiding a real answer to a difficult question".[6]

Frederick G. Wright is a little more promising and considerably less antagonistic than the Bergens. A fair account of the facts of organic evolution is found in his book. He uses the Biblical scheme as evidence for the origin and the antiquity of the human race.[7]

But the preponderance of faulty theories in the books on the library shelves is not to be escaped. Sir Oliver Lodge's work, *Evolution and Creation*, contains a statement which denies point-blank that God created the soul.

> "What is it that first separated man from the rest of the animal creation? Surely it was his sense of free will, the power of choice, the knowledge of good and evil. Apart from domesticated animals, who have learnt something from their association with man, the animals have no sense of that kind: they obey their instincts, they have no sense of right and wrong, no sense of seeing the better and choosing the worse—which is so characteristic of mankind—no sense of sin. But how this sense arose, who is to say! It probably arose gradually like everything else!"[8]

Up From the Ape by Ernest Albert Hooton is a frightening book containing one picture after another of apes in human-like poses. The book itself is an exhaustive account of man's likeness to the ape. But however distasteful this book may be with its ape-ish pictures, it does not state the evolution of the soul. It could be in perfect accord with the Catholic viewpoint.

J. Arthur Thompson's topic *What Is Man?* remains an unanswered question all through the book so far as the author is concerned. He cannot reconcile science and religion but tends towards a monistic view in science and a dualistic view of man's nature in religion. He accents his errors by trying to explain the mind's evolution.

Evolution Yesterday and Today is a fundamental account of the facts of man's organic evolution by Horatio Hackett Newman.

The climax of research of modern thought on evolution is a harmless looking book by G. Elliott Smith entitled *The Evolution of Man.* It reeks of error. Smith attempts to assign man's rationalism to the development of vision, of speech, an appreciation of beauty and form. Atheism is obvious in every phrase.

For me these books are proof that most of our modern scientists are not scientists at all. They are investigating the theory of evolution under the influence of prejudices which cloud their intellects. Neglecting these prejudices, then, what is the truth about evolution? What is the Catholic viewpoint?

The Catholic looks first to the evidences for evolution of the body. Many proofs have been established. Much evidence has been gathered. Mavor gives homology as one of the strong points for evolution of the human body. We understand by homologous organs or other bodily structures those of two individuals in two different species which show the same type of structure, the same relation to the other organs of the body and a close similarity in their embryological origin and development.[9] A class in general zoology observes this resemblance or homology in the frog and man. Systems correspond closely in general plan and often in detail. The skeleton is not the only system. The digestive system seems to differ greatly only where modes of life differ also.

Vestigial organs have been used repeatedly as a proof of the theory of evolution. These organs are

4 *Evolution, the Way of Man*, p. 1.
5 William Keen, *I Believe in God and in Evolution*, 70.
6 p. 7.
7 *Origin and Antiquity of Man.*
8 p. 137.
9 *General Biology*, p. 773.

those which seem to serve no purpose, but which, nevertheless, continue to be developed generation after generation. The vermiform appendix is one example of a vestigial organ; the coccyx, another. Such organs also exist in animals of lower forms.

Just as we compare the structures of the different species we can likewise compare their physiological processes of digestion, assimilation, excretion, and respiration. The physical and chemical processes are compared.

What is held by some scientists as the strongest point in favor of evolution is the embryological proof based on the fact that it is usually only in the later stages of embryonic development that differences appear in the various species. Descent with modification seems to offer the best explanation.[10]

Domestication, cultivation, and experimental breeding are sometimes claimed as proofs for evolution. The different breeds of dogs that have come into existence since their domestication began seems to point to evolution as the explanation of species, for we do know that all the canine breeds have arisen from a single, or at least a very few, wild animal varieties.

Geographical distribution is often cited as another proof of evolution. Centers of dispersal are places where present genera and species have arisen. The distribution, of course, is affected by barriers, geographic isolation, and oceanic islands.[11]

Perhaps more familiar to the average person who has only an average interest in evolution is that proof from paleontology and the fossil record of the occurence of plants and animals on the earth. It seems likely from this study that the simplest groups of plants and animals were the first to appear. The fossil record tends to confirm the arguments from geographical distribution, comparative anatomy, and physiology. The evolution of the horse may be grouped in four phases: the Eohippus, Mesohippus, Merychippus, and Equus. This is but one example of this proof.

But does all this prove that man has evolved so far as his body is concerned? Unprejudiced, we may easily assert that though fossils arranged in descending strata of rock formations prove that lower animals were on earth many ages before man, this doesn't prove man's genetic descent from them. All the proofs offered prove succession in time coupled with similarity in structure, but this certainly does not prove genetic descent.

> To sum up—the evolution of the human body from the body of lower animals has not been proved. With the present technique it is difficult to see how it could ever be proved.[12]

Exploring the evidences offered by science we have found very little proof of actual evolution of the human body. But what of man's soul? Many attempts have been made to prove the evolution of the mind and the soul of man. But the Catholic Church stands firm on this point of evolution. What evidence does she have to offer these critical scientists?

Though the Bible is often discounted by those Catholics who wish to keep strictly to scientific data to break down the evolutionist's standpoint, it is a book of recognized merit even by those outside the Church. It is not a textbook of biology or of zoology, but it contains the truth. Accordingly, when we find a statement in the Bible of the spirituality of the soul of man and the materiality of the human body, we may accept it unhesitatingly. In the *Book of Ecclesiastes* we read:

> I said in my heart concerning the estate of the sons of men . . . that they might see they are themselves beasts. For that which befalleth the sons of men befalleth beasts; even one thing befalleth them; as the one dieth so dieth the other; yea, they have all one breath; so that man hath no preeminence above a beast; for all is vanity. All go unto one place; all are of the dust, and all return to the dust. Who knoweth the spirit of man whether it goeth upward, and the spirit of the beast whether it goeth downward to the earth?[13]

Then the sacred writer answers the problem of the spirituality of the soul in the close of his book: "The dust returneth to the earth whence it was, and the spirit returneth to God who gave it."[14]

Before Ecclesiastes, all mankind have acknowledged their conviction that man is spirit as well as flesh by something not present in the animal—the spiritual soul, deathless and indestructible, which will survive the decay of the organic body. This they have acknowledged through the universal practice of burying of the dead.

Dr. O'Toole voices a strong point on the Catholic viewpoint:

> But if the human mind or soul is spiritual, it is clear that it cannot be a product of organic evolution; no more can it be a product of parental generation. On the contrary, each and every human soul must be an immediate creation of the Author of Nature, not evolved from the internal potentialities of matter, but infused into matter from without. The human soul is created in organized matter, but not from it. Nor can the Divine action, in this case, be regarded as a supernatural interposition, for it supplements rather than supersedes, the natural process of reproduction; and since it is not in matter to produce spirit, a creative act is demanded by the very nature of things.[15]

That the soul is the vital principle, we believe. It is in reality the vital principle of a threefold life: the metabolic life shared with plants; the "sentient life shared with animals and the rational life which is uniquely human".[16] But to prove the soul spiritual would be to prove it incorruptible and therefore opposed to the material. Spirituality involves more than simplicity. To say that the soul is simple is to say it

(Continued on Page Fifty-four)

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[10] Sir John Arthur Thomson, "Evolution", *The Encyclopedia Brittanica*, VIII, p. 926.

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Practical Suggestions

For the Teaching of Science

● By George E. F. Brewer, Ph.D., *(University of Vienna)*
DEPARTMENT OF CHEMISTRY, ROSARY COLLEGE, RIVER FOREST, ILL.

Dr. Brewer concludes the valuable discussion on teaching methods he began in our March issue.

Here he considers how best to condition the student mind to accept changes and advances in science, how to make the pupil a discoverer of facts new to him, and how to see the possible relationships of one fact to another. The danger of drawing conclusions not in accord with the facts is pointed out.

Dr. Brewer gives some hints on good teaching procedures.

PART II

The problems of how to teach science, of how to deal with the ever increasing number of known data, and of how best to provide even during elementary instruction for the inclusion of such data as may be discovered in the future are problems that are not new. They are in fact comparatively old.

How to deal with the number of data is a problem that arises from the steady evolution of science. Its root is, so to speak, a linear function of the time and the scientific work done. From the retrospective point of view, however, we can also observe another evolution of science, an evolution of a more unsteady character, reaching several distinct levels. A science begins by collecting and describing data about nature. Most branches of science have already progressed beyond this phase. The next step is to correlate and integrate facts under a common denominator. The laws of nature are discovered during this period. Even this phase has already been passed by some branches of science, the laws and rules already discovered covering the subject in so many directions that they form a kind of map, guiding the scientist through the many branches of the subject.

In some fields the results achieved in predicting as yet unobserved facts, and in making preconceptions regarding the possible solution of practical and theoretical problems, have made us confident that most scientific problems can be solved. Based on that confidence, an ever increasing number of industries maintain research laboratories. We might almost call them institutions where inventions are ordered, and later delivered. Mankind now does not have to wait for the solution of a certain problem until an invention is made incidentally. Instead, problems are investigated as soon as they become apparent, and a solution is very likely to be achieved.

The consequence of this evolution has been an increased demand for research workers. As a result instruction faces an entirely new problem. Research workers are supposed to offer new ideas or to introduce them into practice. The researcher needs, as all scientists do, a sound knowledge of scientific facts, together with a complete understanding of their theoretical correlation and integration with other facts. Furthermore he needs a special mentality that is quick to see new correlations between facts, a mentality that is conscious of its own ability to find scientific facts and to link them together.

The best way to create an awareness in the pupil of his ability to draw conclusions from facts is to give him practice in drawing conclusions from facts, and to help him check whether his conclusions are in agreement with those other scientists have drawn. In the first part of this paper we pointed out that scientific education should avoid memorization on the part of the pupil by using a system which makes the pupil remember facts. Here a second reason for the same procedure becomes apparent: facts are the basis for the conclusions the pupil should learn to draw.

The mentality of a research worker comprises also another distinct feature: confidence that there will always be the possibility for further evolution in science, that better and still better ways of dealing with scientific problems can be found and will be found. This confidence can be gained from only two sources, one the study of the history of science, the other, a philosophical analysis of the fundamentals of science.

The history of science teaches us that no scientific problem has ever been finally settled. Even problems which ostensibly allow only a single answer, even data which seem not to offer the slightest chance to subsume them under another theory, later turned out to fit well into other theories if looked upon from a different point of view. Sometimes the customary point of view and the resultant conclusions seem to be eternal, because they stand unshaken even for centuries. Nevertheless some have had to be abandoned over night, when new facts became known which offered new points of view. An example will illustrate.

For milleniums it was believed that properties and qualities are something that can be added to matter, the latter thus being transformed from one kind of matter into another. It was the genius, Robert Boyle,

those which seem to serve no purpose, but which, nevertheless, continue to be developed generation after generation. The vermiform appendix is one example of a vestigial organ; the coccyx, another. Such organs also exist in animals of lower forms.

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For milleniums it was believed that properties and qualities are something that can be added to matter, the latter thus being transformed from one kind of matter into another. It was the genius, Robert Boyle,

who realized that properties are inseparable characteristics of the individual substance itself, and that there is only a very limited number of substances which form the constituents of all other substances. For these ultimate kinds of matter, which themselves cannot be divided into different varieties, Robert Boyle adopted the term "elements". Then, slowly and woefully, a new branch of science came into being: chemistry. Chemistry as a science originated from Boyle's definition of elements. Its very existence seemed to be inseparably connected with that basic idea. Nevertheless some fifty years ago discoveries were made about certain substances which proved that a few of these elements can and do transform themselves into other and different elements. Consequently the definition of an element, the very foundation of chemistry, had to be changed. Today we have in principle returned to the idea of Boyle's predecessors, to the idea of the alchemists who wanted to find suitable operations for converting those kinds of matter which Boyle called elements, into others. We think that we have found that suitable operation—the application of energy, energy applied in so "concentrated" a form that as yet we have no device in common use for its production.

Do we now believe that Robert Boyle and all the chemists of the last three centuries were wrong, because we had to change our theoretical conception of elements? No. We admire their achievements. They were scientists as we are. They observed nature, and the facts they discovered will never change. Our theoretical correlation of these facts is what has changed. Since there are hundreds of examples of theories which have had to be abandoned, we may safely conclude that all our theories will sooner or later share the same fate. More than this, we even *hope* that our theories will share that fate, because we hope that science will always discover new facts to the increasing benefit of mankind.

If we assume all this, then the situation, looked upon from the philosophical point of view, is as follows: Science investigates what we call facts. These facts are the reports which the senses of a normal individual make to his consciousness, and it is our consciousness which draws conclusions from these reports. Certainly these reports offer the possibility of relating them to other reports. That means correlating and integrating facts. Sometimes, however, it appears as if our conclusions could offer more than this; as, for instance, these two statements concluded from facts: "Substances consist of ultimate particles" and "Substances combine in fixed proportions by weight". These statements seem to offer a *reason* for one another. The study of these ultimate particles, however, suddenly opened a view into a hitherto unknown world, a world in the best sense of the word, a tiny solar system. The problem of the combination of two of these ultimate particles involves problems of the kind and variety that the movement of the planets in the universe does.

This is only one example, but we may, and have to, generalize it. We may say that the only answers we receive from science are answers in which facts are correlated with each other. We have to educate our pupils to realize this, and to bear constantly in mind that science merely correlates facts, the reasons for the existence of these facts being beyond the sphere of the human mind. If we achieve this mentality in the pupil, then we have achieved the first step in making a modern scientist. We have then created a mentality that is ready to draw new conclusions as soon as new facts become known, that mentality which appreciates science and its achievements, without overestimating the ability of the human mind, being aware of its limits.

Further instruction should follow the lines best suited to establish this mentality firmly in the mind of the pupil, and also best suited to teach the ways of its use in science. Much experience has already been gained in how best to achieve the latter. Explanatory lectures, demonstration of experiments, and laboratory work are the main features of our methods of teaching. Great care, however, should be taken not to anticipate conclusions, but to base instruction upon facts and then to draw conclusions in the form of laws or theories. In addition, we must give instruction regarding the technique of investigation and the discovery of hitherto unknown facts. We have to show to the pupil how to create his only guide for dealing with new facts in research work. It is the preconception, formed by conclusions which are based *per analogiam* on known facts. The next step is to show how carefully the newly investigated facts must be checked to learn if they are really in accordance with the preconception. During the checking the worker must be ready to abandon the preconception at a minute's notice whenever the facts point in another direction. Our best way of demonstrating all this, is to show how discoveries have been made in the past. We must teach not only what has been discovered but how it was discovered.

The date when a certain discovery was made is not of great moment, though it should be mentioned, but the personality of the discoverer is important. In the focus of interest are the scientific facts known at the time, and, eventually, the then common theory. In the focus of interest for our purpose should be not so much the history of science or the biography of scientists as the history of human thought. This should be given more consideration than is now usual in elementary science instruction.

The history of science is full of excellent examples of ingenious preconceptions. Some of these serve not only to illustrate the intimate relationship between the branches of science, but to show likewise the limits of the human mind. They are warning examples, showing that any theory is wrong as soon as it loses immediate contact with the facts.

About a hundred years after Sir Isaac Newton had discovered the laws of gravity, an ingenious chemist, Count Claude Louis Berthollet, formed the preconcep-

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NEW BOOKS

Photograph by Robert Turiff Hance

Biology for Better Living

• *By* ERNEST E. BAYLES, University of Kansas, and R. Will Burnett, Stanford University. Silver Burdett Company, New York, N. Y. 1942. xiv + 754. $2.28.

In this high-school text book the authors have gathered together a mass of material for the presentation of the interrelation of the facts of life along lines currently favored in schools of education. The book is long and the illustrations many and good. It seems possible that the text may indeed be so long as to interfere with the ready grasp of the possibilities of biology for better living. *R.T.H.*

Organic Identification

• *By* J. L. B. SMITH, Rhodes University College. Chemical Publishing Co., Inc., Brooklyn. 1942. 48 pp. $1.50.

A very brief, practical outline that may be used to advantage in identifying members of the common groups of organic compounds. Certain standard procedures have been simplified, sometimes to a considerable degree. Much information is arranged in tabular form. Very few errors were noted.

While this book will not take the place of more elaborate treatments of the subject, it will prove helpful in a number of ways, especially to the beginner. *H.C.M.*

Technidata Hand Book

• *By* EDWARD L. PAGE. Norman W. Henley Publishing Co., New York. 1942. 64 pp. $1.00.

A mimeoprinted, spiral bound collection of scientific information, formulas, and tables dealing with mathematics, physics, chemistry, engineering, and mechanics, compiled by one who states that as a student he was unable to locate quickly some of the information of this nature that he needed. The work might be helpful to students, but it will not take the place of the standard reference books. Some of the information included is of doubtful value. The book is not well printed. *H.C.M.*

Desert Wild Flowers

• *By* EDMUND C. YAEGER, Stanford University Press, 1941. xxx + 332. $3.50.

The second, revised edition of a useful book containing photographs, line drawings and brief structural and habitat descriptions of 764 wild flowers found in our western deserts. *R.T.H.*

Torch and Crucible

• *By* SIDNEY J. FRENCH. Princeton University Press, Princeton, N. J. lx + 285. $3.50.

Fascinating as a fictional best seller, this biography of a great scientist will compel your close attention until you have finished it. Antoine Lavoisier's years from his young manhood until his death on the guillotine during the French Revolution were packed with drama. Professor French has not missed any of it.

Here is the story of the man, the scientist and the Frenchman, his domestic, scientific and political affairs, his successes and his mistakes, his enemies and his friends (including the du Ponts). Rich in revealing incidents, sympathetic in its interpretations, accurate in its facts, this book is a "must" for every library of science. *H.C.M.*

Acids and Bases

• *By* NORRIS F. HALL AND OTHERS. Journal of Chemical Education, Easton, Pa. 1941. vii + 103. $1.00.

This little collection of papers by eight different writers is as the Journal of Chemical Education intends it to be, a valuable "contribution to chemical education."

Many teachers have a vague idea that chemists are changing their ideas about the nature of acids and bases and their behavior under different conditions, but they have not kept up with recent trends of thought. Here is a brief and clear presentation of the situation as it now exists. In this compact volume, Messrs. Hall, Briscoe, Hammett, Johnson, Alyea, McReynolds, Hazelhurst and Luder demonstrate clearly that chemistry is not a "dead" science.

Every teacher of chemistry can use the information this book contains. *H.C.M.*

Chemistry

• *By* GERALD WENDT, Ph.D. John Wiley & Sons, Inc., New York. 1942. 300 pp. $1.75.

This book represents chemistry in "The Sciences," a series edited by Dr. Wendt. Intended as a textbook for survey courses in colleges, it is written carefully and in an attractive style. Necessarily the author has greatly simplified much of the material he presents, but he has not hesitated to include discussions of hydrogen ion concentration, colloids, catalysis, atomic structure, amphoteric properties, oxidation and reduction and other topics that sometimes trouble students of chemistry.

This is one of the best survey texts in chemistry the reviewer has seen. *H.C.M.*

Basic Laboratory Practice

• *By* NORMAN G. SPRAGUE, Chemical Publishing Co., Inc., Brooklyn, N. Y. 1941. vii + 124 pp. $3.50.

This is a different kind of laboratory book, dealing not with specific exercises but with general operations. It is to be used to supplement the ordinary manual, not to take its place. The busy teacher will appreciate the minute and detailed but highly necessary pointers concerning good technique that this little book provides for beginners. The book is elementary and it is intended to be, but there are few laboratory workers who will not be able to find helpful hints in it. First aid, fire prevention, simple manipulations such as pouring chemicals and loosening stoppers, the care of thermometers, glass working, distillation, filtration, drying, weighing, and other operations are studied in detail. The handling of dangerous chemicals receives attention. Simple volumetric manipulations are discussed. Even study habits are not overlooked.

The price of the book seems to be high. *H.C.M.*

Microbes Which Help or Destroy Us

• *By* P. W. ALLEN, D. F. HOLTMAN and LOUISE ALLEN MCBEE, University of Tennessee. C. V. Mosby Co., St. Louis, Mo. 1941. pp. 540. $3.50.

This book, which is designed especially to acquaint the layman with microbes, narrates the major roles which microbes play "in the production of health, homes, food, clothes, fuel and defense." It presents a wealth of material of practical value to those who would make use of the beneficial activities of microbes most effectively or who desire to avoid contact with harmful ones. Microbial diseases are discussed, the more widely prevalent and more serious ones at considerable length. Several chapters deal with such aspects of the subject as the influence of microbiology on surgery, the use of antiseptics and disinfectants, and community health activities.

Chapters are devoted to food poisoning, food preservation, safe drinking water, the use of leaven in bread, milk and milk products, vinegar making, Bang's disease in cattle, hog cholera, the disposal of sewage and garbage, water, friendly microbes and the nitrogen cycle, and many other topics.

The teacher of microbiology should find this book a useful and reliable reference. It will be helpful to the student because of its clarity and because of the large amount of factual material it contains. *E.V.*

Man and the Vertebrates

• *By* ALFRED SHERWOOD ROMER, Harvard University. The Chicago University Press, Chicago, Illinois. 1941. viii + 405. $3.50.

Three editions of a book within eight years suggests strongly that it has registered favorably. This is all the more true when the book is a text and must serve as a supplement to course work that will, and should, vary with each instructor. Packing four hundred pages with concise fact, Dr. Romer has taken time to make these facts easy and even fascinating to read. Before the reader is spread the anatomical evidences of relationships between vertebrates, and a stronger case is made for the reliability of the conclusions because the author never fails to point out the present gaps in the facts and the loopholes in the theories. *Man and The Vertebrates* will be most useful as a source book for courses in evolution, comparative anatomy or in general zoology. It is excellent general reading. The chapters on human origins, races, and structures are especially interesting. The book does not seem particularly well adapted as the sole text in any one course in zoology as the courses are now offered. *R.T.H.*

Science Controls Pests

(Continued from Page Forty-five)

bomber of death, loaded with destructive germs. If the novelist contends that all wars are directly or indirectly caused by a woman, the scientist is equally certain that the female mosquito wreaks more havoc than the male. She carries the dread malaria germs, transporting them from one person to another. No welcome sound is the low drone of this miniature Stuka zooming to the attack. Science has discovered that the most effective way of getting rid of this pest is complete elimination of breeding places. When swamps and marshes have been abolished the mosquito is automatically destroyed. A thin coat of oil spread over breeding places will suffocate the young by shutting out their air supply. Sprinkling an infested room and clothing with aromatic substances such as camphor and citronella disposes of the adult.

The house fly, known to scientists as Musca Domestica, has been called the most dangerous animal alive. St. Francis of Assisi may have referred to him as "Brother Fly", but most people have no desire for such intimate relations with him. Flies carry many disease germs on their bodies, and transport them from garbage cans or sewage dumps directly to the family table. Typhoid and intestinal germs are the specialties of this small black pursuit plane of death. Pyrethrum extract in kerosene is an effective fly spray. One of the safest poisons to use, and also one of the most satisfactory, is three teaspoonfuls of commercial formalin in one pint of milk or water.

The louse, a very informal insect, constitutes the fifth columnist of the army, for he stirs up discontent wherever he goes. Any one of the American doughboys who went over seas in the first World War can tell about the discomfort of spending weeks of time in the company of a few hundred cooties. Nor will he deny that the louse is an important factor in breaking down army morale. The louse thrives in filth and dirt and attaches itself to the hair of men and animals. Sterilization of clothing, regular bathing, plus kerosene and vinegar rinses for the hair to remove lice eggs, are

very effective means of shortening the life span of this pest.

The story of the discovery of a common insecticide used to combat the louse is very interesting. It seems that a few louse-ridden Allied soldiers went to sleep in a field of Rumanian chrysanthemums. When they awoke every body louse was dead. This was all the information alert scientists needed. Their experiments resulted in the production of a concentrated form of chrysanthemum pollen, known as pyrethrum powder, which is an end-all for the louse.

Then there is the kinsman of the louse, that small brown parasite, the bedbug. He is a rather cunning creature. Contrary to popular belief, it does no good to place cans of kerosene under the bedposts to prevent his climbing into the bed. He climbs to the ceiling, and just like the modern invader at Pearl Harbor, parachutes down on the unsuspecting occupant of the bed. The exterminator gasses him with deadly hydrocyanic fumes which have a high penetrating power, wafting murder in their breath.

No army is complete without a cavalry section. Owing to the fact that the cockroach, like a racehorse, is built for speed, he covers a wide expanse of territory. One of his accomplishments is the spreading of every imaginable disease, from tuberculosis to scarlet fever. Sodium fluoride and sulfur fumigation are the two most effective ways of exterminating this pest, and the silverfish and various moths as well, although the silverfish is controlled most cheaply by sprinkling a mixture of oatmeal, arsenic, sugar, and salt over the infested area.

From the foregoing evidence no one will be inclined to deny that household pests present a serious problem, and that while scientists have played a major role in combating them, there is much yet to be accomplished. Although the Black Death of the fourteenth century is subject matter for historians, as are the rats who carried the plague, we are still overrun with the progeny of those same rats. We believe that science is winning the fight. The mosquito, tiny but deadly, no longer presents the problem it did in the years of the Panama Canal project. Similarly, with the co-operation of science, the fly will be eliminated, or its numbers, at least, greatly reduced. The army must be stopped if man is to enjoy the God-given rights of life, liberty, and the pursuit of happiness. Where these pests dominate, man is not free, his life is not his own, and he cannot possibly remain happy. Science, in its never-ending battle to give us those rights in the material sense, is conquering. ●

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Sugar in the Diet

(Continued from Page Forty-one)

Glucose, produced very cheaply from corn starch by hydrolysis, offers perhaps the greatest possibilities. Besides being inexpensive, this sugar is the natural sugar of the blood. It is the sugar selected by nature as the energy transporter in the animal and vegetable kingdom. Long looked upon by the food industry as a "filler" in cheap candy, glucose is now recognized as a source of readily available energy. Glucose in syrup form contains dextrins and other substances that prevent crystallization. Hence it is known in most households as table syrup. In recent years a pure powder form of glucose has been made available. Unfortunately glucose is not as sweet as sucrose; neither does it possess the fine crystallization properties of sucrose.

Problems of the Sugar Industry

This industry that is so closely identified with children's more blissful moments, and which permeates everyday life to an almost incredible extent, has been the object of too little serious attention. It has served as a topic for satire, for broad humor, and for all kinds of attack, but for serious general attention, hardly at all. Yet it is one of the most interesting phenomena of our current commercial and social existence, and it ranks among our major industries.

How much speculation about the quantity of candy that would be eaten, or not eaten, has been indulged in concerning the effects of prohibition and repeal? How much conversation on the effect of sugar on feminine comeliness?

> As Eugene Pharo has said, "Who has never debated with himself whether he would lose all his teeth if he did not conquer his appetite for candy or whether the cargo of sugar in his stomach might not land him in the ranks of diabetics? What person has never had even temporary fear that the attractive colors of confections that he or his children munched would tint his tonsils vermillion, his esophagus scarlet and green, turn his stomach into a kaleidoscope of poisonous hues?"

In spite of man's fears, sugar continues to be a principal item in his diet. Will wartime conditions change his tastes? Will other industries spring up to supplement the demand for sweetness in our diet? ●

★ ★ ★ ★ ★

We *Counsel* you to read "Training the Lay Science Teacher" in the May, 1942, number of *The Journal of Higher Education*, written by Thomas Morse Barger of Illinois State Normal University. Dr. Barger criticizes the science courses now being given in teachers' colleges because they merely duplicate those offered in liberal-arts colleges. He considers teachers' colleges to be strictly professional schools like schools of law and medicine. The science courses they offer should be aimed at preparing the teacher to teach the science well under the working conditions found in the usual high school. This is not being done. New procedures are suggested. ●

Catholic View of Evolution

(Continued from Page Forty-eight)

is "inextended, uncompounded, incorporeal, and not dispersed into quantitative parts or particles".[17] As such it pertains to a different order of reality than ponderable matter. Nevertheless, even animal souls are simple in so far as they are incorporeal and not dispersed into quantitative parts, but they are intrinsically dependent on matter and are therefore in the last analysis material principles.

Hence all this does not prove the human soul to be spiritual and it is this point alone that differentiates the soul of the human from the soul of the beast. All the psychic activities of the animal, such as sensation and imagination, are organic functions of the sensitivo-nervous type. Their agent is not the soul alone, but the soul-informed organism. The purely animal soul is totally immersed in matter as regards both operation and existence. "It exists, not for its own sake, but merely to vivify and sensitize the organism".[18] Now a spiritual soul can exist without matter and, then, does not exist for the same purpose as the brute soul. It is supermaterial and immortal and does not need a body to maintain itself. Surely such a soul can not be evolved but must come into being through an act of creation!

Another factor to be considered in proving our composite natures is the occurence of irreconcilable conflict or opposition. There is evidence of "warring factions"[19]—our national and our sentient functions. Surely where there is such opposition a distinction must be recognized. A second fact is the domination of our reason and will over our cognitive and appetitive functions of the organic or sentient order.

> Our intellect criticizes, evaluates, and corrects the data of sense perception, it discriminates between objective percepts and illusions . . . Moreover it not only shows its superiority to sense by supervising, revising, and by appraising the data of sentient experience, but it manifests its discontent at the inaccuracy and limitation of the senses by the invention and use of instrumentation (e.g., ear trumpets, spectacles, etc.) to remedy the defects of sense-perception. This phenomenon is without parallel among brute animals.[20]

The question of instinct in animals is answered by sense, not by intelligence as a principle of instinct. Many reliable authorities agree with the Catholic viewpoint, then, that man's soul did not, and could not, evolve from the animal. Joseph Husslein states this emphatically:

> The impossibility of an evolution of the soul of man, a spiritual and simple being, from the purely material brute with no higher faculty than brute instinct, is evident.[21]

Let us conclude that the subject of the evolution of man's body is much too broad to be settled in so short a paper. But the Catholic viewpoint can be given briefly by the simple statement that God creates each soul. Whether the body of man has evolved is a much debated question which remains unproven by any scientist. With St. Augustine we can assume that God is the Creator of all things and that the world created by Him has evolved independently and automatically. Then we have an even greater idea of God for the force of any cause is the greater the further the action extends.[22] If God created matter, primordial substance and, through natural causes imposed upon it, allowed the world to evolve, then the more it redounds to His glory. Therefore, we can see that evolution as a scientific hypothesis and a theory is perfectly compatible with Christian doctrine concerning the origin of things.

This theory, being Catholic, is Theistic in foundation. The atheistic theory of evolution is "ineffectual to account for the first beginning of the cosmos or for the law of its evolution, since it acknowledges neither creator nor lawgiver".[23]

Therefore, not in blind faith but with the gift of understanding which makes the doctrines of our creed the beautiful ones they are, we may exclaim as in the Holy Sacrifice of the Mass:

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[17] *Ibid.*, p. 210.
[18] *Ibid.*, p. 214.
[19] *Ibid.*, p. 234.
[20] *Ibid.*, p. 267.
[21] *Evolution and Social Progress*, p. 83.
[22] Bertram Windle, *The Church and Its Reactions with Science*, p. 128.
[23] H. Muckermann, "Evolution", *The Catholic Encyclopedia*, V, p. 655.

O God, Who in a marvellous manner didst create and ennoble human nature, and still more marvellously hast renewed it![24]

And then should we bow our heads humbly that with our finite minds we have dared to question the wonderful ways of the Infinite God! ●

[24] Prayer from the *Missal* in the Offertory of the Mass.

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The Cooperative Committee on Science Teaching

Under the sponsorship of five scientific societies representing Biology, Chemistry, Mathematics, Physics, and Research in Science Teaching a committee has been formed to work on educational problems of vital interest to all science teachers which no single organization can solve working alone. The committee is known as the Cooperative Committee on Science Teaching.

Two meetings have been held, one in April and one in November, 1941. Work is now in progress on four problems:

1. Licensing or certification of secondary-school science teachers. The committee hopes to work out a solution that will be practicable and that will be adopted by certification authorities.

2. The college training of prospective science teachers. It is desirable to prepare teachers for teaching certain combinations of subjects rather than to prepare intensively in one subject.

3. Exploratory studies of the secondary-school science curriculum. The Committee hopes to stimulate a number of colleges and universities to organize workshops and conferences for bringing together secondary, school teachers to work on their educational problems.

4. Problems of state or local agencies needing the services of educational consultants on questions pertaining to science teaching. The committee offers its services as a consultant to state or local agencies working on problems pertaining to science teaching.

The Committee consists of the following members:

Representing the American Association of Physics Teachers—K. Lark-Horovitz, Purdue University; Glen W. Warner, Wilson Junior College, Chicago.

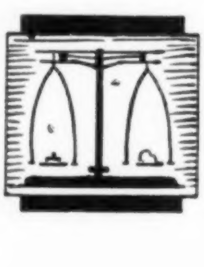
Representing the American Chemical Society—B. S. Hopkins, University of Illinois; Martin V. McGill, Lorain High School, Lorain, Ohio.

Representing the Mathematical Association of America—A. A. Bennett, Brown University; Raleigh Schorling, University of Michigan.

Representing the National Association for Research in Science Teaching—G. P. Cahoon, Ohio State University; Robert J. Havighurst, University of Chicago.

Representing the Union of Biological Societies—Oscar Riddle, Carnegie Station for Experimental Evolution.

Robert J. Havighurst is Chairman of the Committee and Glen W. Warner is Secretary. ●



Origin of Coal, Oil and Gas

(Continued from Page Thirty-five)

plastic stage has been obtained, hard and dense coke results. It is possible, therefore, to produce from carbohydrate-containing plants sandy or coking coals, the latter producing porous or dense coke. These artificial coals give practically the same amount of primary coke and primary tar at 500°C (930°F), and the same amounts of secondary coke and secondary tar at incoalification temperatures between 800° and 1000°C (1470-1830°F), as natural bituminous coals.

All our efforts to produce from lignin and from lignites true bituminous coals and anthracites, especially those which give dense coke, have been in vain. Lignin and its conversion products upon incoalification do not give enough bitumen of the right quality. Pure lignin completely free of carbohydrates gives none, or very little, bitumen. Both quantity and quality of bitumen are essential so that coals may give sandy, dense or porous coke.

By increasing the quantity of alkaline reacting material, for instance lime, limestone or dolomite, in ratio to carbohydrate, the formation of residual coal can be suppressed. Material which is identical with the bitumen of natural and artificial coals becomes the main product. This so-called protoproduct, upon further incoalification, has been converted into materials which in all respects are identical with natural asphalts. These artificial and natural asphalts, either by hydrogenation or by cracking, have been converted into crude oils which show the same main constituents, aliphatic, aromatic and hydroaromatic hydrocarbons, that are found in natural oils.

The presence of aromatic hydrocarbons in natural and artificial crude oil is of great significance. Of like importance is the fact that in natural asphalts and in crudes chlorophyl and haemin (plant dyestuffs and blood pigments) are found. These are destroyed quickly at temperatures above 200°C (390°F). Therefore, in most cases natural coals and oils must have been formed at relatively low temperatures. These temperatures are too low for the conversion of the aliphatic hydrocarbons produced from the fats of dead fish into aromatic hydrocarbons. The conversion of carbohydrates into aromatic hydrocarbons, in contrast to the conversion of aliphatic hydrocarbons into aromatic hydrocarbons, can be carried out at low temperature.

Our studies have proven, therefore, that carbohydrates are the parent materials of bituminous coals and anthracites, as well as of asphalts and crude oils. These studies have also shown that asphalt is the parent material, not a derivative of crude oil. They have shown furthermore that natural gas is formed during all the transformation stages of carbohydrates into solid and liquid hydrocarbons.

The formation of solid and liquid fuels in nature and in the laboratory from carbohydrate-containing material is an intramolecular combustion process which forms, besides carbon dioxide and water, many other interesting intermediate products. With the main process which furnishes energy, energy-consuming processes are combined. Consequently a very complicated system of compounds results which is called crude oil and asphalts.

Our studies concerning the origin of solid, liquid and gaseous fuels at first had only academic interest. In the near future they may have practical value. If we extract coals and oils and natural gas from the ground and use them up, then they are gone, and the reconversion of a small part of them into fuels may take many, many millions of years. On the other hand, nature, especially in warmer climates, puts tremendous amounts of carbohydrates at our disposition anew every year. Using the light energy of the sun and with the help of chlorophyl, nature forms these important materials from carbon dioxide and water by a not completely explained photochemical reaction. Indulging in statistics for a moment, we may state that the total world-reserves of liquid fuel could be produced from the carbohydrates which are produced under the present climatic conditions on earth during seven years. This figure is based on yields which have already been obtained in the laboratory.

The largest amounts of carbohydrates per acre are produced by the cultivation of sugar cane. Sorghum, potatoes, maize, corn, cornstalks, bagasse, algae, seaweed, etc., in a word any carbohydrate-containing material, may serve for the production of either solid or liquid or gaseous fuels.

For the production of the 70,000,000 tons of gasoline which were used in 1941 for the 32,000,000 cars on the highways of the United States, 7,000,000-10,000,000 acres would have to be planted with sugar cane. More acres would be needed if sorghum, potatoes, maize or corn were to be used for this conversion. For the production of alcohol for use as liquid fuel for these 32,000,000 cars, 85,000,000 acres would have to be planted with sugar cane in order to obtain the required amount of carbohydrates for the necessary fermentation process. The previously mentioned 7,000,000-10,000,000 acres are only a small fraction of the 300,000,000 acres which represent the total crop acreage in the United States.

The conversion of newly produced carbohydrates would allow the saving of a part of the precious materials which nature has kept for us over a long period of time. Therefore, our studies, which started years ago with the intention of getting some insight in an important group of geochemical reactions, may now become practical and important. ●

Training Physicists

The American Institute of Physics is concerned about training students in physics for defense purposes.

The present emergency demands that every effort be made to increase the supply of personnel trained in the applications of the physical sciences. They will be called upon to put physics to work in the defense industries, in the civil service of the United States Government, and in the armed forces. Our country has been caught desperately short in the supply of such men because careers in physics have not been brought adequately to the attention of high school students.

Tens of thousands of such individuals are necessary now and many more will be called in the immediate future.

All boys and girls showing a natural aptitude for laboratory work and a reasonable skill in mathematics and physics should be given the opportunity to acquire as much physics instruction as possible. They will be of maximum usefulness if they have had at least two years of mathematics.

We are in particular need of the maximum number of people trained in the fundamentals of electricity. We ask you therefore to instruct all the vocational guidance officers to urge these youngsters to go on to college wherever this is financially possible, majoring in physics, mathematics, and engineering fundamentals. All radio amateurs in high school should especially be urged to continue their education immediately after graduation, either by entering college or by taking appropriate courses at the nearest engineering defense training center.

Information and advice as to the need for scholarship and financial support for particularly able students should be brought at once to the attention of the nearest engineering defense training center. ●

An Ancient Metropolis in Salvador

In a mountain-fringed valley about 25 miles northwest of the Central American city of San Salvador archaeologists of the Carnegie Institution of Washington are excavating ruins of an ancient metropolis which may have been one of the greatest population centers of the New World in its day.

Over the entire floor of the valley, an area of about 48 square miles, are more or less thickly scattered mounds which mark aboriginal building sites. The old city lay on both sides of the Rio Sucio, which flows through the site.

The most imposing group, perhaps the religious and administrative center of the city, lies near the middle of the valley on the west bank of the river. It consists of a great plaza, roughly 600 by 400 feet in area, enclosed on three sides by mounds of various dimensions. On the south there is a court about 20 feet high which is partly enclosed by ruined structures.

The excavations show evidence of aborginal human habitation over a long, but as yet undetermined, period of time. The earliest remains, pieces of pottery and other artifacts, are covered with about ten inches of volcanic ash in which there are no evidences of human beings. Sometime after this episode the development of the principal structure began.

The ancient Americans built imposing pyramids of molded adobe blocks. All exposed surfaces were covered with an excellent lime plaster which was frequently renewed. Presumably these pyramids once were crowned by temples. Stairways were constructed up their sides. ●

Borodin

(Continued from Page Forty-three)

and Borodin suggested an analogy in the formation of amarin from lopin. Modern formulae for these compounds are in accordance with this view:

amarin *lopin*

Borodin studied aromatic aldehydes in great detail. He was engaged in this work at the time of his death. His scientific contributions were distributed over a period of about twenty-five years. His work was hindered by disheartening and needless interruptions by reason of his routine duties at the Academy, many of which could well have been alloted to a lesser man.

All through the years his musical labors had been as constant as his chemical research, although composing never interfered with his other work. He himself considered music as an avocation, something to do when duties were not pressing or when he was not well. Rimsky-Korsakoff must have realized this. Once, on hearing that his friend was confined to his bed with a slight case of influenza, he unthinkably remarked, "Good".

His completed first symphony was performed in 1868 at St. Petersburg where it had a very mild success. The academic critics of the time had little sympathy for the efforts of the Circle in attempting to found a nationalistic music. In view of the modern acceptance of this symphony, the report of a critic of the time is interesting: "A symphony was also performed, a new work by a fellow named Borodin, and was applauded loudly and at great length by his friends, several of whom were in the audience."

This was followed by a second symphony; a tone poem, On the Steppes of Central Asia; much instrumental music; an opera, Prince Igor, and a third symphony, both unfinished at his death.

We are indebted to Nicholas Rimsky-Korsakoff for a fairly complete picture of the Borodin household. His kindness and patience made him a great favorite of the students of the Academy. In addition, Borodin had successfully campaigned for the admission of women students to the Medical Academy. Many of these considered themselves his proteges, and were his constant visitors. After Catherine's excellent dinners, a little group — Korsakoff usually included — would discuss everything from the classes at the school to the latest in music. Rimsky-Korsakoff writes that more than once when they would be deep in a technical discussion of the embryonic third symphony Borodin would spring up and dash across the hall where he was distilling some liquid from one container to another, "transforming emptyness into vacancy" as he put it.

But these were not the only visitors likely to be found. In-laws and relatives were likely to appear any time. Wrote Korsakoff, "Their apartment was often used as a shelter or a night's lodging by various poor (or visiting) relations who picked the place in which to fall ill or lose their minds."

It should not be inferred that this occasional topsy-turvy annoyed Alexander in the least, or that it interfered seriously with domestic tranquility. His open-hearted nature would not allow such a thing. He would usually treat the situation with a dash of humor. His marriage was apparently idylic and a step which he never once had cause to regret.

Borodin's position in science and art is a much discussed one; even a debated one. Someone once said that he was much too normal a person to have been a true genius, a term which commonly is understood to mean an individual with an excess of brain cells as well as an overabundance of mannerisms and peculiarities which invariably make life miserable or unbearable. Borodin had not a one-track mind as had Mendeleeff. He was never involved in the political difficulties which were hum-drum for Wagner. He was never found in the philosophical and religious controversies characteristic of a Berthelot. He did not share the matrimonial wretchedness of Tschaikowsky. Experts cannot agree whether he was an artistic chemist or a scientific musician, and they usually compromise by admitting that he was both in equal measure. It is scarcely proper to term him "famous"; *illustrious* is a better word. Without doubt, he was one of the greatest of the 19th century Russian chemists, and Liszt placed "his chemist friend from St. Petersburg" among the greatest musicians of the age.

On February 28, 1848, Borodin was laughing and talking with some of the guests when he was suddenly stricken and died without a word—the victim of a ruptured heart aneurism. Thus came the unexpected and unfortunate end of one who had "loved music as he loved science." He had lived long enough to disprove the words of his old schoolmaster, Zinn, for surely, "two hares" had been successfully hunted indeed. Without the help of modern knowledge and training, Alexander Borodin had produced contributions to man's culture and knowledge which will live forever. What greater test is there for true greatness? ●

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Visual Education

(Continued from Page Thirty-nine)

In the foregoing, the use of visual education as an art, rather than a collection of elaborate paraphernalia, is emphasized. Moreover its purpose is not to amuse the pupil but to make him wonder and speculate; it is to stimulate the good student, not to entertain the poor student.

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[1] L. A. Goldblatt and J. E. Bates: "Preparation of Lantern Slides Without a Camera," *J. Chem. Educ.*, **17,** 462 (1940).

[2] Cellophane sheets 9¾ x 12 x 0.008", 2400 P. T. cellophane, may be purchased from Dobeckman Co., 3301 Monroe Ave., Cleveland, Ohio., for about $5 per 50 sheets. This gives 600 slides 3¼ x 4".

[3] Radio-Mat Slide Co., 1819 Broadway, N. Y. C. $1.50 for 50 mats.

[4] S. V. E. Slide Binders from the Society for Visual Education, 100 E. Ohio St., Chicago, Ill.; $3.75 for 100 mounts, including glass plates.

[5] See reference 6; also pamphlet: "Sources of Visual Material," by the Spencer Lens Co., Buffalo, N. Y.

[6] H. N. Alyea: *J. Chem. Educ.*, **16,** 308, 1939, and **18,** 146, 1941.

[7] Eastman Kodak Direct Positive Film Developing Outfit. Reversal film may be purchased in 100 ft. rolls at a fraction of the cost of 3 ft. rolls.

[8] Kodaslide Ready-mount Changer, by the Eastman Kodak Co., Rochester, N. Y. Cost, Approximately $10.

[9] Paper blackboards, 2-sided silicate black veneer plates, from the N. Y. Silicate Book Slate Co., Inc., 20-24 Vesey St., New York City. Boards 48 x 53¼" cost about $7.

[10] Relay, type CXH 1027, mercury contact relay, single pole, front contact, coil 6V, 60 cycles A. C. Type H-3 sheet metal hinged cover. Struthers Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa. Cost about $13.

[11] List of motion picture films compiled by the American Chemical Society, and sent to your local A. C. S. secretary.

[12] Erpi Classroom Films, Inc., 35-11 Thirty-fifth Ave., Long Island City, N. Y.; Edited Pictures System, Inc., 330 W. 42nd St., New York City; Eastman Kodak Co., Rochester, N. Y.

[13] Teaching Films Custodians, 25 West 43rd St., New York City: "Catalogue of Films for Classroom Use," price, 50 cents.

[14] W. O. Puckett: *Science*, **91,** 625, 1940. Ethyl Methacrylate as a Mounting Medium for Embryological Specimens.

Book Campaign

Books by the million will change hands in the National Defense Book Campaign which started in January, 1942, for readers in homes throughout the land will share the books they have enjoyed with our soldiers, sailors, and marines.

The Campaign, sponsored by the American Library Association, American Red Cross, and United Service Organizations, seeks ten million books for U. S. O. houses, Army "dayrooms," ships, Naval bases, etc. Books should be taken to libraries, where they will be sorted, repaired if necessary, and sent on as quickly as possible to the spots where men in the service want books.

Put your name and address in the books you give—the boys will be so interested to know "who gave what!" ●

Practical Suggestions

(Continued from Page Fifty)

tion that the course of chemical actions might follow the gravity principle. He investigated the precipitation of salts out of solutions, observing that the amount of the precipitate formed depends upon the relative amount of its constituents in the solution. This phenomenon is now called mass action. Berthollet went a step further and detected that in some cases even the nature of the precipitate is changed by the addition of another substance to the solution. He also determined that the relative amount of the added substance will decide the nature of the precipitate. Berthollet thus detected reversible reactions and the equilibrium they tend to reach. All this is now usually brought in form of the following chemical expressions:

Solution of AB upon addition of C forms a precipitate AC.
Solution of AC upon addition of B forms a precipitate AB.

Or: $AB + C \leftrightarrows AC + B$

Berthollet observed that the presence of one substance influences the formation of another substance, and for that reason he concluded that no substance of definite composition can exist, since its formation necessarily must take place in the presence of other substances which must influence the process. Berthollet *concluded* this, and in this he was wrong, because it was in reality not a conclusion but a preconception for he did not, as he should, check whether his statement was in accordance with the facts or not. Immediately another scientist, Louis Joseph Proust, then a professor in Madrid, answered Berthollet. Proust had formed no preconception. He just analyzed substances, with the best methods then known, and found that the analysis proved that chemical substances are of a definite composition, regardless of the circumstances which lead to their formation. Thus Berthollet, though starting from correctly observed facts, was proved to be in contradiction, regarding his conclusions, to the highest court in science: to the fact. Berthollet thus lost not only the acknowledgment of his work, but what is more deplorable, he barred the way for further research along that line, a line which appeared to be so completely wrong for the sole reason that Berthollet had put forward his ideas in the form of a conclusion instead of a preconception. It was not until fifty years later that Berthollet's ideas were taken up again when their sound basic principle was realized by Gouldberg and Waage.

The utmost care should be taken, as the example cited illustrates, to establish in the minds of our pupils that mentality which stresses the value of facts above all else. No theory should be presented as a statement. Experiments should be demonstrated to the pupil or, better, carried out by the pupil. Then possible conclusions should be discussed. Finally the best conclusion, that is, the one which includes the greatest number of facts and which is for the time being not at variance with other known data, should be shaped into a theory.

Assuming this, the method of instruction is quite clear. But we have to take into consideration also one of the greatest difficulties the teacher encounters, the limited number of periods of instruction at his disposal. We should, therefore, choose carefully the experiments we carry out.

Whenever possible, we should select experiments which allow several conclusions, each in a different aspect but each unmistakably the only conclusion for the respective aspect. This not only saves time, but it also can be used to show to the pupil a number of ways of interpreting a single experiment. To give an example for this: A suitable setup, consisting chiefly of two graduated tubes can be used to demonstrate the influence of heat and pressure on the volume of two different gases. If the tubes are connected to each other, changes in pressure during the time of diffusion can be observed until a final pressure is reached.

This diffusion experiment was demonstrated to a college freshmen class, and the students were asked to write what they had seen. Quite a large number of them had not observed the temporary rise of pressure in one of the gas chambers although the rise was approximately two inches of water pressure. The experiment was repeated, and after all the observed data had been tabulated and discussed the conclusions known as Boyle's law, Charles' law, Graham's law of diffusion and Dalton's law of partial pressure were formulated. Finally the kinetic theory of gases was introduced, not as a reason for the facts but as a possible abstraction, as a conclusion which will be considered valid until facts become known that are irreconcilable with this theory.

These methods of teaching the fundamentals of science may be helpful in developing the students because they avoid tedious memorization, they can be brought into a system which actively creates and leads interest, they are based upon scientific broadmindedness, making the pupils eager to look out for hitherto undiscovered facts, and preparing them to trust in an unlimited future development of science. ●

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"Perhaps we may say that the chief function of science, in the social world at least, is to make predictions, and make them quantitatively. The eternal question is less "why" than "how much". The "why" of any action, when known, becomes "how", and from these "hows" scientific principles are developed. . . . . But mere measurement without regard to the relevancy of facts, is scarcely science, even though scientific equipment and jargon be employed. Unfortunately, there are some so-called scientists who are concerned, neither with the fundamental laws nor their application. The former requires tasks beyond their strength and the latter is beneath their academic dignity."

CHARLES E. KELLOGG
The Scientific Monthly, 54, 5, 445

Non-Science Courses

(Continued from Page Thirty-four)

1. Mental training. That is, mental gymnastics, the modern substitutes for Latin and Greek.
2. General knowledge.
3. Preparation for life work.

I wonder how many of you have listened to any of the quiz programs now current on the radio. I have listened to a number of them, each time with rising gorge. I do not need to tell you, as modern educators, that when a majority of a group of students fail in examinations upon a subject on which they have received instruction, the onus rests not on the students but upon the quality of instruction.

The abysmal ignorance shown by the majority of the participants in these quizzes, on matters of general knowledge, would, if collected and published as horrible examples, constitute the most vitriolic indictment of American education which could be presented by the most biased antagonist.

Today, our schools are readjusting themselves to war conditions. They are faced with the problem of speeding up education, particularly on specialized subjects which will fit our citizens to carry on totalitarian war to victory. Yet upon them rests the responsibility of maintaining—yes, better still, of raising—the general educational level, in order that a new generation may not be deprived of its legitimate foundations upon which it must rest to carry on the obligations of citizenship.

Telescoping of courses, elimination of unessentials, all fashion of time saving devices are on the cards insofar as the colleges are concerned. From one short-range point of view these are desirable and necessary. Unless such abridgements in curricula are accompanied, however, by a corresponding broadening adjustment of the high school curricula, to take up the load, and to present to the college a product prepared for these adjustments of his further education, the educators of America will have failed, from the long-range viewpoint.

Which brings us squarely back to the subject, essential non-science courses for the preparation of qualified high school science teachers.

To my mind, the essential is geopolitics. I do not like the word particularly, but, after all, it covers the subject. Unless the teacher be qualified to instruct the student accurately and impartially, on the facts of life, the relationships of nations, the paths of conquest—commercial and military, it is impossible to teach history, other than as a prosy list of dates, meaningless and unsatisfactory. Yet history is essential. Economics, government and history are so closely interrelated that without coordinated study the interpretation of cause and effect is entirely lost.

Based upon a knowledge of geopolitics current events take on a different aspect. They are not just a collection of unrelated incidents and coincidences, but are part and parcel of life itself. The student of geopolitics is armed against one of the most potent weapons of psychological warfare—confusion.

The science teacher, who today is unable to see in his particular specialized field some element of service integrated as part of the national effort in totalitarian warfare, is sitting in a tower of ivory. Worse yet, he is gathering his students into the same cloistered recess, a recess into which some day the clanking colossus of war will crash, drowning in its thunder the last faint wail of the wishful thinker: "It can't happen here." ●

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The American Science Teachers Association

Have you become a member of the American Science Teachers Association?

This Association is the largest and most important organization of science teachers in the country. Among its affiliated groups are some twenty-two local, state and regional groups in which are enrolled the most progressive teachers of science in the colleges and secondary schools of the United States.

If you are a teacher of science of any kind you are eligible. Send your one-dollar membership fee to the Treasurer, Leo J. Fitzpatrick, Brockton High School, Brockton, Mass. The membership fee includes a one year's subscription to *The Science Teacher*, a quarterly journal which is the official publication of the Association. We *Counsel* you to join.

Mr. Cadet Teacher:

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sending pictures by radio or by telegraph? How far can he get in an explanation of talking pictures? What does he know about airplanes and aviation in general? Can he give a satisfactory discussion of the different types of aerial bombs used in warfare? Does he know how to take care of an incendiary bomb in case of an air raid?

In my chemical and physical science classes there are always a few students well enough informed on the advance of science to know if an explanation is satisfactory or not, and no teacher can command the respect of his class unless he can keep ahead of its better informed members. Do not attempt to hide your lack of knowledge by the use of big words and involved sentences. It is better to admit to your students that there are some things you do not know rather than to try to bluff. It is easier "to fool all the people" than it is to fool keen boys in a physics or chemistry class. If you are wrong on some point in question, and know you are wrong, frankly admit your error to the class. They will respect you the more for so doing.

Since science trains the individual to search for truth and not personal opinion, the science teacher must be a master of his subject. He must also keep in mind that even though the person who makes no mistakes accomplishes little, it is also true that the person who makes too many mistakes is in danger of losing his job. ●

Coming . . .

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